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Idaho Operations Office

In Situ Bioremediation Remedial Action Work Plan for Test Area North Final Groundwater Remediation, Operable Unit 1-07B

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Prepared for the
U.S. Department of Energy
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ABSTRACT

This Remedial Action Work Plan identifies the approach and requirements for the implementation of in situ bioremediation as the hot spot remedy for Test Area North, Operable Unit 1-07B. A separate remedial design will be submitted providing drawings, specifications, and plans for construction of the hot spot remedy. Additionally, an Operations and Maintenance Plan and Groundwater Monitoring Plan will be prepared as a separate submittal to implement the requirements detailed in the Remedial Design/Remedial Action Work Plan.

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ACRONYMS

ARAR	applicable or relevant and appropriate requirement
ARD	anaerobic reductive dechlorination
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
CWSU	CERCLA waste storage unit
D&D	decontamination and decommissioning
DOE	Department of Energy
DOE-ID	Department of Energy Idaho Operations Office
EPA	Environmental Protection Agency
ESD	explanation of significant differences
FDR	Field Demonstration Report
FFA/CO	Federal Facility Agreement and Consent Order
GWMP	Groundwater Monitoring Plan
GWTF	Groundwater Treatment Facility
HASP	Health and Safety Plan
IDEQ	Idaho Department of Environmental Quality
INEEL	Idaho National Engineering and Environmental Laboratory
IRC	INEEL Research Center
ISB	in situ bioremediation
M&O	management and operating (contractor)
MCL	maximum contaminant level
MNA	monitored natural attenuation
MSA	management self-assessment
NCP	National Contingency Plan
NLCID	no longer contained-in determination

NPTF	New Pump and Treat Facility
NPV	net present value
O&M	operation and maintenance
OU	operable unit
PDO	predesign operations
PDP	predesign phase
PM/CM	performance/compliance monitoring
RAO	remedial action objective
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RD	remedial design
ROD	Record of Decision
SOW	Scope of Work
SRPA	Snake River Plain Aquifer
SVOC	semivolatile organic compound
TAN	Test Area North
TFR	technical and functional requirement
TSF	Technical Support Facility
VOC	volatile organic compound
WAG	waste area group
WMP	Waste Management Plan

In Situ Bioremediation Remedial Action Work Plan for Test Area North Final Groundwater Remediation, Operable Unit 1-07B

1. INTRODUCTION

This Remedial Action Work Plan (RAWP) has been prepared in accordance with the Idaho National Engineering and Environmental Laboratory (INEEL) Federal Facility Agreement and Consent Order (FFA/CO) (DOE-ID 1991) by the Department of Energy Idaho Operations Office (DOE-ID). The plan addresses the implementation of in situ bioremediation (ISB) as the hot spot remedy of the Test Area North (TAN) Technical Support Facility (TSF) injection well (TSF-05) and surrounding groundwater contamination (TSF-23). The groundwater plume that emanates from the TSF injection well has been designated as Operable Unit (OU) 1-07B. This Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC § 9601 et seq.) remedial action will proceed in accordance with the signed OU 1-07B Record of Decision (ROD) Amendment (DOE-ID 2001a). The *Remedial Design and Remedial Action Scope of Work Test Area North Final Groundwater Remediation Operable Unit 1-07B* (DOE-ID 2001b) identifies and describes the scope, schedule, and budget the agencies have agreed are necessary for the implementation of this remedial action (in accordance with the 2001 ROD Amendment).

The ROD Amendment (DOE-ID 2001a) modifies the original remedy for OU 1-07B at TAN. The modification was chosen in accordance with CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 300). The documents that form the basis for the decisions made in this ROD Amendment are contained in the Administrative Record for OU 1-07B. This decision satisfies the requirements of the FFA/CO entered into among the Department of Energy (DOE), the Environmental Protection Agency (EPA), and the Idaho Department of Environmental Quality (IDEQ).

1.1 Remedial Action Summary

The Remedial Design/Remedial Action (RD/RA) Scope of Work (SOW) (DOE-ID 2001b) defines the scope, schedule, and budget for implementation of the OU 1-07B Final Remedial Action, as required by CERCLA (42 USC § 9601 et seq.) and the FFA/CO (DOE-ID 1991) and in accordance with the ROD Amendment (DOE-ID 2001a). The final remedy for OU 1-07B clean-up combines ISB for hot spot restoration and monitored natural attenuation (MNA) for distal zone restoration with pump-and-treat (selected in the 1995 ROD [DOE-ID 1995]) for the medial zone, providing a comprehensive approach to the restoration of the contaminant plume. The remedy also includes groundwater monitoring and institutional controls. The OU 1-07B remedy will prevent current and future exposure of workers, the public, and the environment to contaminated groundwater at the TSF injection well site. Table 1-1 lists the contaminants of concern (COCs) in the vicinity of the TSF-05 injection well.

Table 1-1. Contaminants of concern in the vicinity of the TSF-05 injection well.

Contaminant	Maximum Concentrations[a]	Federal Drinking Water Standard
VOLATILE ORGANIC COMPOUNDS		
Trichloroethene (TCE)	12,000 – 32,000 ppb	5 ppb[b]
Tetrachloroethene (PCE)	110 ppb	5 ppb[b]
cis-1,2-Dichloroethene (DCE)	3,200 – 7,500 ppb	70 ppb[b]
trans-1,2-DCE	1,300 – 3,900 ppb	100 ppb[b]
RADIONUCLIDES		
Tritium	14,900 – 15,300 pCi/L[c]	20,000 pCi/L
Strontium-90	530 – 1,880 pCi/L	8 pCi/L
Cesium-137	1,600 – 2,150 pCi/L	119 pCi/L[d]
Uranium-234	5.2 – 7.7 pCi/L[c]	27 pCi/L[e]

ppb = parts per billion pCi/L = picocuries per liter.

a. The concentration range is taken from measured groundwater concentrations at the TSF-05 injection well (INEEL 1999).

b. ppb is a weight-to-weight ratio that is equivalent to micrograms per liter (μg/L) in water.

c. Maximum concentrations of tritium and U-234 are below federal drinking water standards and baseline risk calculations indicate cancer risk of 3×10^{-6}. While this risk is smaller than 1×10^{-4}, both tritium and U-234 are included as COCs as a comprehensive plume management strategy.

d. The MCL for Cs-137 is derived from a limit of 4 millirem per year (mrem/yr) cumulative dose-equivalent to the public, assuming a lifetime intake of 2 liters per day (L/day) of water.

e. The federal drinking water standard for U-234 is for the U-234, -235, and -238 series.

This remedial action will permanently reduce the toxicity, mobility, and volume of the contamination at the site. The components of the remedy for restoration of the OU 1-07B hot spot, medial zone, and distal zone of the contaminant plume (illustrated conceptually in Figure 1-1) include:

- **Hot Spot**—ISB promotes bacterial growth by supplying essential nutrients to bacteria that naturally occur in the aquifer and are able to break down contaminants. An amendment (such as sodium lactate or molasses) is injected into the secondary source area through the TSF-05 injection well or other wells in the immediate vicinity. Amendment injections increase the number of bacteria, thereby increasing the rate at which the volatile organic compounds (VOCs) break down into harmless compounds. The amendment supply is distributed as needed, and the treatment system operates year-round.
- **Medial Zone**—Pump and treat involves extraction of contaminated groundwater, treatment through air strippers, and reinjection of treated groundwater. Air stripping is a process that brings clean air into close contact with contaminated liquid allowing the contaminants to pass from the liquid into the air where they quickly evaporate. In accordance with the original remedy selected in the 1995 ROD (DOE-ID 1995), construction of the New Pump-and-Treat Facility (NPTF) in the medial zone was completed in January 2001. The facility started routine operations on October 1, 2001.
- **Distal Zone**—Natural attenuation is the physical, chemical, and biological processes that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in groundwater. MNA includes groundwater monitoring with annual performance reviews for the first 5 years to compare actual natural degradation rates to predicted degradation rates, followed by additional periodic reviews thereafter.

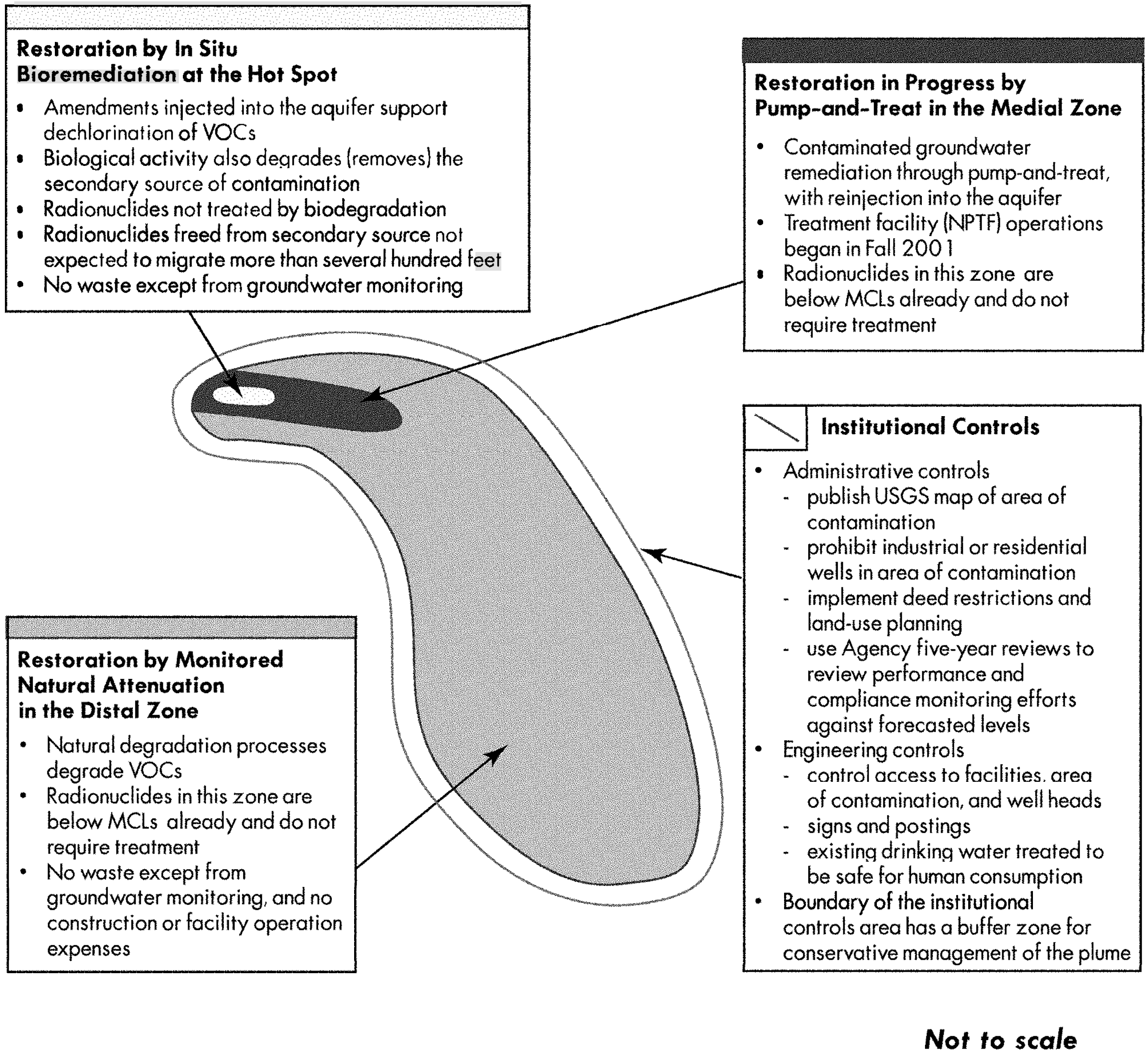

Figure 1-1. Conceptual illustration of the components of the amended remedy.

- **Institutional Controls**—Engineering and administrative controls will be put in place to protect current and future users from health risks associated with groundwater contamination. During the early part of the restoration timeframe, the contaminant plume continues to increase slowly in size until the natural attenuation process overtakes it. Modeling suggests that growth of the distal zone of up to 30% might occur, reaching its maximum size in about 2027 (as defined by the 5 ppb TCE isopleth). However, since institutional controls will be in place, there will be no change in risk to human health or to ecological receptors. Under this alternative, continued groundwater monitoring and computer modeling will be used to track the plume boundary; the institutional controls area will be modified, as required, to maintain a conservative buffer zone around the contaminant plume area.
- **Monitoring**—Groundwater monitoring will be conducted throughout the plume, with samples analyzed to determine the progress of the remedy. Water level measurements will be completed to verify the ability of the NPTF to contain and treat the contaminants in the medial zone.

- **Contingencies**—Contingencies identified under the remedy include:
  - For the medial zone, monitoring wells located upgradient of the NPTF will be monitored on a routine basis to ensure that concentrations of radionuclides in the groundwater remain low. If monitoring indicates that the concentration of radionuclides in the NPTF effluent would exceed maximum contaminant levels (MCLs), the Air Stripper Treatment Unit (ASTU), located between the hot spot and the NPTF but not currently operating, will be used to prevent those radionuclides from traveling downgradient to the NPTF.
  - For the distal zone, if the agencies determine that MNA will not restore the distal zone of the plume within the restoration timeframe, pump-and-treat units will be designed, constructed, and operated in the distal zone to remediate the plume. The contingency remedy also will be invoked if the required monitoring necessary for MNA is not performed.

Under the remedy, the concentrations of the radionuclide COCs in the hot spot and medial zone will meet the remedial action objectives (RAOs) of the ROD within the remedial timeframe through natural attenuation processes. Concentrations of the radionuclide COCs in the distal zone already meet the RAOs. The groundwater monitoring program will include monitoring the attenuation of radionuclide COCs in hot spot and the medial zone. If monitoring indicates that the concentration of radionuclides in NPTF effluent would exceed MCLs, then the medial zone contingency would be implemented. The frequency of monitoring at selected medial zone and distal zone locations depends on the potential risk of exceeding MCLs in the NPTF effluent. The agencies will use the monitoring results to determine appropriate responses.

1.2 Scope of the ISB Remedial Action

This RAWP outlines a comprehensive process that follows the governing CERCLA and FFA/CO requirements for implementation of ISB at TAN. This step-by-step process integrates project team input and agency input at critical milestones in accordance with the RD/RA SOW (DOE-ID 2001b). This RAWP has been developed in concert with several supporting documents to document the basis for long-term ISB operations. It identifies and establishes the ISB system technical and functional requirements (TFRs), design requirements, applicable or relevant and appropriate requirements (ARARs), and the requirements for operation, monitoring, and reporting. The supporting documentation provides technical methods, procedures, and protocols for implementing the requirements defined in this RAWP. The following sections establish the requirements for several key areas, which are summarized in the following sections. These requirements are established to guide the remedial action implementation in achieving the RAOs, including the compliance and performance requirements set forth in Section 2.

1.2.1 Technical and Functional Requirements

This RAWP provides the problem statement and technical basis necessary to develop the ISB TFRs. These requirements identify the operation and performance requirements necessary to prepare the ISB design. They are established to bracket the key operating and monitoring parameters that are necessary for the ISB system to achieve the RAOs. This RAWP summarizes the primary elements of the ISB TFRs that the agencies have agreed are the ISB design basis.

1.2.2 Remedial Design

This RAWP describes the design preparation and approval process, including a discussion of the proposed design. This will include a brief description of the process facility and its capabilities, along with descriptions and capabilities of support structures, appurtenances, and ancillary equipment.

1.2.3 Agency RD/RA Review and Approval

The CERCLA and FFA/CO process, the ROD (DOE-ID 1995), and the RD/RA SOW (DOE-ID 2001b) require agency input, review, and concurrence at the completion of certain actions and prior to starting other actions. This RAWP integrates project team and agency review, inspection, and input into the required areas during the process of implementing this remedial action and defines the objectives, procedures, and process by which the agencies and the project will review and concur with the remedial action. Additionally, the process by which the agencies can concur that the remedial action is operational and functional is presented. This process will be comprised of a shakedown and initial operational period with clear and measurable performance criteria and objectives, an operational and monitoring strategy showing attainment of the stated objectives, and the preparation of the ISB remedial action report. This process will include requirements for agency pre-final and final inspections (if required).

1.2.4 Interim Operations

Interim operations are the period between the approval of this RAWP and the start of initial operations. Initial operations will start with the completion of the new ISB injection facility. Interim operations will be a continuation of the pre-design operational activities and will cover activities that support selection of an electron donor, development of electron donor injection strategies, ISB model refinement, and continued ISB groundwater monitoring.

1.2.5 Remedial Action Construction

This RAWP identifies and defines activities, processes, hold-points, inspections, and other requirements necessary to ensure that the remedial construction meets the quality and regulatory requirements specified in the remedial design.

1.2.6 Operation

This RAWP will define the operational strategy that meets the ROD, RAOs, and performance and compliance requirements. This will include defining the requirements for procedures, protocols, and processes that will govern routine operations.

1.2.7 Groundwater Monitoring

The requirements for a groundwater monitoring strategy will be developed that provide the data necessary to evaluate the effectiveness of ISB at achieving stated remedial action performance and compliance objectives. This RAWP shall establish the data quality objectives (DQOs) and the quantity, quality, and type of analysis necessary to objectively measure performance.

1.2.8 Agency Remedy Performance Review

This RAWP lays out the basis by which the agencies will perform remedy performance reviews; establish the basis by which performance will be measured; and delineate the process, format, and schedule of reports, inspections, and reviews.

2. REMEDIAL ACTION OBJECTIVES

Remedial action objectives were defined in the 1995 ROD to specify expected remedy performance during the three phases of the 1995 ROD remedy implementation strategy. One RAO was defined for each of three phases: Phase A, Phase B, and Phase C. A separate RAO was defined for the institutional controls to ensure the controls remained in place during the life of the remedial action. Changes documented in the *Explanation of Significant Differences from the Record of Decision for the Technical Support Facility Injection Well (TSF-05) and Surrounding Groundwater Contamination (TSF-23) and Miscellaneous No Action Sites, Final Remedial Action* (INEEL 1997a [INEEL/EXT-97-00931]) and results of the treatability studies led to a revision of the Phase C RAOs. These modified Phase C RAOs have been adopted as the final RAOs, as discussed below.

2.1 Remedial Action Objectives Defined in the 2001 Record of Decision

Changes and results documented in the explanation of significant differences (ESD) (INEEL 1997a) and the *Field Demonstration Report, Test Area North Final Groundwater Remediation, Operable Unit 1-07B* (DOE-ID 2000a) prompted a refinement of the Phase C RAOs. The agencies agreed to the following final RAOs for the entire contaminant plume:

- Restore the contaminated aquifer groundwater by 2095 (100 years from the signature of the 1995 ROD) by reducing all COCs to below MCLs and a 1×10^{-4} total cumulative carcinogenic risk-based level for future residential groundwater use and, for non-carcinogens, until the cumulative hazard index is less than 1.

- For aboveground treatment processes in which treated effluent will be reinjected into the aquifer, reduce the concentrations of VOCs to below MCLs and a 1×10^{-5} total risk-based level.

- Implement institutional controls to protect current and future users from health risks associated with 1) ingestion or inhalation of, or dermal contact with, contaminants in concentrations greater than the MCLs, 2) contaminants with greater than a 1×10^{-4} cumulative carcinogenic risk-based concentration, or 3) a cumulative hazard index of greater than 1, whichever is more restrictive. The institutional controls shall be maintained until concentrations of all COCs are below MCLs and until the cumulative carcinogenic risk-based level is less than 1×10^{-4} and, for non-carcinogens, until the cumulative hazard index is less than 1. Institutional controls shall include access restrictions and warning signs.

Restoration of the hot spot under the remedy will not directly affect radionuclide concentrations in groundwater. The geochemical behavior of the radionuclides in the subsurface acts to bind them to soil and rock in the area where they now are located. This will continue to prevent them from migrating beyond the vicinity of the hot spot and from being available to future drinking water users. This behavior supports the presumption that, throughout the restoration period, radionuclide concentrations in water extracted from the aquifer downgradient from the hot spot will remain below MCLs and 1×10^{-4} cumulative carcinogenic risk-based levels and, for non-carcinogens, the cumulative risk will remain less than 1. Estimates of radionuclide attenuation by sorption and radioactive decay indicate that Cs-137 and Sr-90 will meet RAOs throughout the contaminant plume by 2095. Sorption of radionuclides from the dissolved phase to subsurface materials prevents these radionuclides from being present in the drinking water of future users. The remaining radionuclides (U-234 and tritium) are currently below MCLs and 1×10^{-4} cumulative carcinogenic risk-based levels.

2.2 Compliance and Performance Objectives for In Situ Bioremediation

The general compliance and performance monitoring objectives for ISB consist of demonstrating meaningful progress toward restoration of the hot spot-contaminated aquifer groundwater by 2095 (100 years from the signature of the 1995 ROD) by reducing all COCs to below MCLs and a 1×10^{-4} total cumulative carcinogenic risk-based level for future residential groundwater use and, for non-carcinogens, until the cumulative hazard index is less than 1. These monitoring objectives will be met through the collection of monitoring data that demonstrate: 1) complete dechlorination of VOCs to prevent, to the maximum extent practicable, migration of VOCs above MCLs beyond the hot spot; 2) degradation of the source area; and 3) restoration of the plume by 2095. These objectives are divided into three specific compliance objectives and two performance objectives, as follows:

Compliance Objectives:

- Reduce downgradient flux from the hot spot such that VOC concentrations are less than MCLs
- Reduce crossgradient flux from the hot spot such that VOC concentrations are less than MCLs
- Maintain the reduction of downgradient crossgradient flux from the hot spot of VOC concentrations below MCLs.

Performance Objectives:

- Achieve electron donor distribution throughout the hot spot and associated biogeochemical reactions
- Achievement of source degradation.

2.3 ISB Implementation Strategy

For the OU 1-07B ISB remedial component, a phased implementation strategy is planned. The planned implementation strategy provides a sequenced approach designed to provide the time necessary to optimize electron donor addition prior to the start of long-term operations and to monitor secondary source degradation. The ISB implementation phases are:

1. Interim Operations – Interim operations will be a continuation of the pre-design operational activities and will cover activities that support a better understanding of alternate electron donors, development of injection strategies that support initial operations, ISB model refinement, and continued ISB lactate addition.

2. Initial Operations – This phase will focus on reducing the flux of VOCs from the hot spot in the downgradient direction. During this phase, data will also be gathered and analyzed relating to achievement of long-term performance objectives.

3. Optimization Operations – This phase will focus on reducing the flux of VOCs from the hot spot in the crossgradient direction, while maintaining VOC flux reduction in the downgradient direction. During this phase, data will continue to be gathered and analyzed relating to achievement of long-term performance objectives.

4. Long-term Operations – This phase will focus on achievement of hot spot source degradation, while maintaining the reduction of VOC flux from the hot spot in the crossgradient and downgradient directions.

Each phase has specific completion criterion which, when achieved, lead to the next phase or completion of the remedy component. The completion criteria for a given phase require the monitoring and evaluation of certain ISB performance parameters. Table 2-1, the ISB RAO performance/compliance matrix, contains the description of the objectives for each phase, the completion criteria, and the performance and compliance monitoring requirements for evaluating. A summary schedule of the ISB implementation strategy is presented in Figure 2-1.

The performance and compliance monitoring requirements and objectives presented in this section are strictly related to ISB. The ISB Groundwater Monitoring Plan provides the implementation strategy and requirements for the ISB monitoring program. This plan also defines the requirements for groundwater sampling in support of other OU 1-07B remedial component performance and compliance monitoring requirements. Table 2-2 provides a crosswalk between the three monitoring zones and remedy performance and compliance monitoring requirements. This provides an overview of where a particular remedy components sampling program may be gathering sample data in support of another remedial component.

Table 2-1. ISB RAO performance/compliance monitoring objectives.

Remedy Phase	Monitoring phase/Decision Types[1,2]		Criteria for completion of the Phase	
Objective	Performance	Compliance		Notes
Interim Operations Continue system operations to reduce contaminant flux from the hot spot	Routinely monitor performance of the ISB system with respect to indicator parameters including VOCs, tritium, ethene/ethane/methane, redox parameters, electron donor, bioactivity, and nutrients; determine whether or not operational changes are required.	N/A	Completion is defined as start-up of the final remedy treatment system	
Initial Operations This phase will focus on reducing the flux of VOCs from the hot spot in the downgradient direction. During this phase, data will also be gathered and analyzed relating to achievement of long-term performance objectives.	Routinely monitor performance of the ISB system with respect to indicator parameters including VOCs, tritium, ethene/ethane/methane, redox parameters, electron donor, bioactivity, and nutrients; determine whether or not operational changes are required.	Monitor concentrations of VOCs at TAN-28 and –30A for a period of one year to verify concentrations remain below MCLs.	Determine that for a period of 1 year, downgradient axial flux from the hot spot has been reduced such that VOC concentrations remain less than MCLs, as measured at TAN-28 and –30A.	Initial ops starts with completion of construction.
Optimization Operations This phase will focus on reducing the flux of VOCs from the hot spot in the crossgradient direction, while maintaining VOC flux reduction in the downgradient direction. During this phase, data will continue to be gathered and analyzed relating to achievement of long-term performance objectives.	Routinely monitor performance of the ISB system with respect to indicator parameters including VOCs, tritium, ethene/ethane/methane, redox parameters, electron donor, bioactivity, and nutrients; determine whether or not operational changes are required.	Monitor concentrations of VOCs at PMW-1 and PMW-2 for a period of one year to verify concentrations remain below MCLs.	Determine that for a period of 1 year, crossgradient flux from the hot spot has been reduced such that VOC concentrations remain less than MCLs as measured at PMW-1 and PMW-2.	Optimization starts at the end of initial ops. - The completion of optimization operations will lead to a Remedial Action Report and a functional and operational determination. - PM/CM reports periodic with frequency no less than every 5 years.
Long-term Operations This phase will focus on achievement of hot spot source degradation, while maintaining the reduction of VOC flux from the hot spot in the crossgradient and downgradient directions.	Routinely monitor performance of the ISB system with respect to indicator parameters including VOCs, tritium, ethene/ethane/methane, redox parameters, electron donor, bioactivity, and nutrients; determine whether or not operational changes are required.	N/A	The completion criteria for long-term operations will be specified in the ISB Remedial Action Report.	- PM/CM reports periodic with frequency no less than every 5 years. - Long-term operations start at the completion of optimization.

1. Decision Types are inputs to the DQO Process described in the Groundwater Monitoring Plan (GWMP).
2. VOCs: PCE, TCE, cis- and trans-DCE, vinyl chloride
   Redox parameters: pH, ORP, dissolved oxygen, ferrous iron and sulfate
   Electron donor: COD, specific conductivity, lactate, acetate, propionate, butyrate
   Bioactivity: alkalinity
   Nutrients: ammonia, nitrogen, orthophosphate.

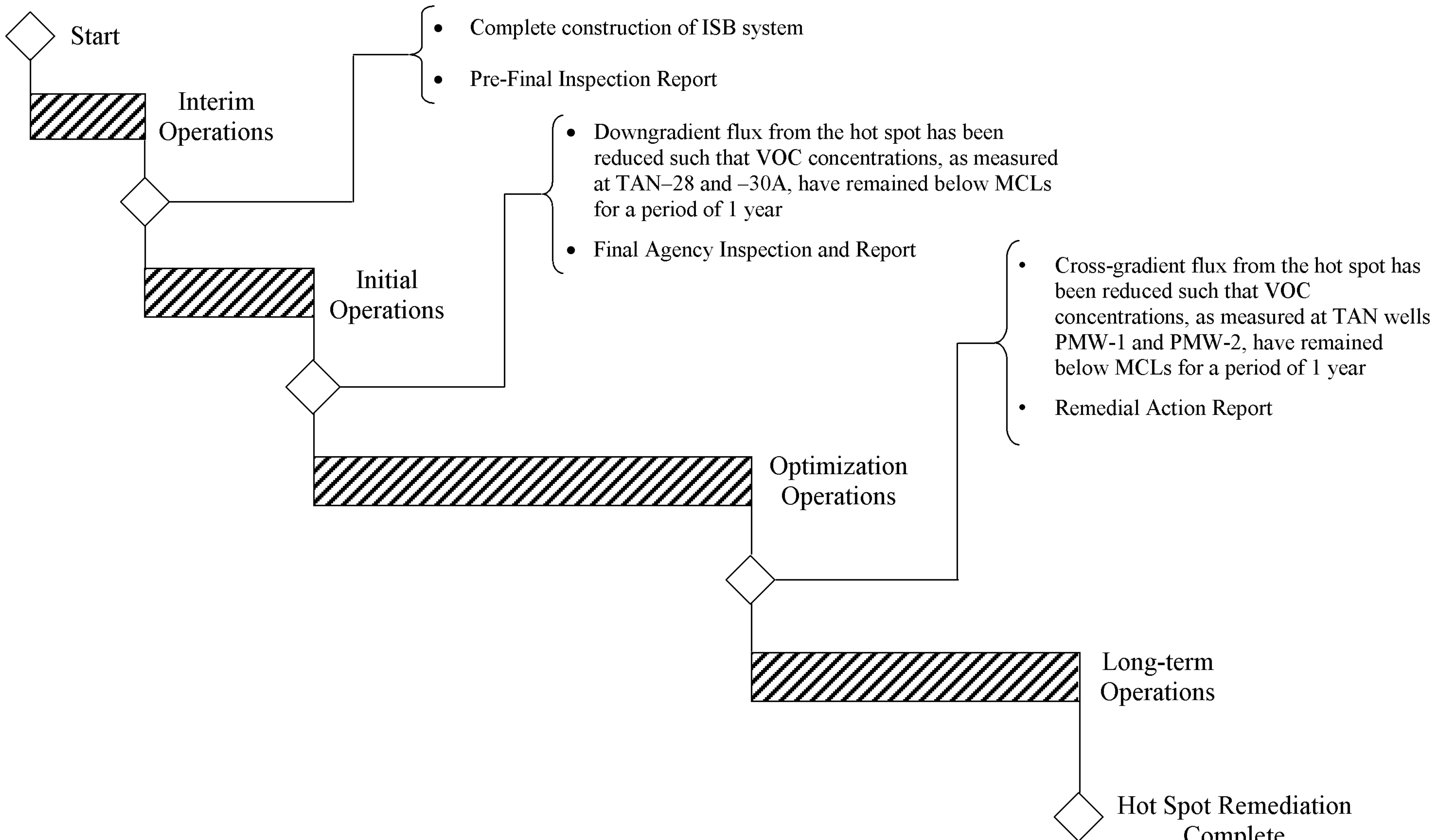

Figure 2-1. Summary schedule of the ISB implementation strategy.

Table 2-2. OU 1-07B groundwater remediation remedy monitoring crosswalk table.

Monitoring Zone	Monitoring/Sampling Type	Monitoring Purpose	Sample Program	Basis Document	Notes
<u>Hot Spot</u>	ISB Performance Parameters	ISB Performance	ISB	ISB Work Plan	Monthly for Performance Monitoring
	ISB Performance Parameters	ISB Flux	ISB	ISB Work Plan	Quarterly for Compliance Monitoring
	VOCs plus Radionuclides	Medial Zone Source Control	ISB	NPTF Work Plan	Quarterly; NPTF Contingency Trigger
	VOCs plus Radionuclides	Distal Zone Upgradient Source Control	ISB	MNA Work Plan	Annual
<u>Medial Zone</u>	Plume Capture	NPTF Performance	NPTF	NPTF Work Plan	Water Level Measured
	NPTF Facility	NPTF Compliance	NPTF	NPTF Work Plan	Uptime, Influent, Effluent, Flow Rate
	TCE/Tritium	Distal Zone Upgradient Source Control	MNA	MNA Work Plan	Annual
<u>Distal Zone</u>	TCE/Tritium	MNA Performance • Breakthrough • Plume Expansion • Degradation Rate	MNA	MNA Work Plan	Annual

3. STATUTORY DETERMINATIONS AND ARAR COMPLIANCE

Under CERCLA, Section 121, and the NCP (40 CFR 300), the agencies must select remedies that are protective of human health and the environment, comply with ARARs, are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ, as a principal element, treatment that permanently and significantly reduces the toxicity, mobility, or volume of hazardous wastes, and has a bias against off-site disposal of untreated wastes. Section 9 of the ROD Amendment (DOE-ID 2001a) discusses how the ISB meets these statutory requirements.

Implementation of the remedy will comply with the substantive portions of all specified ARARs. Table 3-1 lists the ARARs that are applicable to the ISB remedial component.

3.1 Compliance with Applicable or Relevant and Appropriate Requirements

Remedial actions at CERCLA sites must establish and comply with the substantive portions of the legal applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations (collectively referred to as ARARs), as required by Section 121(d) of CERCLA (42 USC § 9601 et seq.) and NCP Section 300.430(f)(1)(ii)(B).

3.1.1 Clarification of ARARs

In accordance with IDAPA 37.03.03.050.01, which deals with the construction and use of injection wells, the agencies have agreed that, to support ISB, amendments containing constituents above MCLs may be injected so long as injected fluid will not endanger a drinking water or groundwater source for any present or future beneficial use (DOE-ID 2001a).

3.1.2 Threshold Criteria

The threshold criteria requirements for ISB include: 1) overall protection of human health and the environment, and 2) compliance with ARARs.

3.1.2.1 Overall Protection of Human Health and the Environment—ISB will be protective of human health and environment by eliminating, reducing, and controlling the risks posed by the site through treatment of groundwater contaminants. ISB will treat the groundwater contaminants by injecting an amendment that will enhance biological growth resulting in dechlorination of contaminants within the hot spot without bringing the contaminated groundwater to the surface. ISB will also reduce toxicity by destroying TCE and other chlorinated VOCs in situ and will directly reduce the volume of the secondary source.

3.1.2.2 Compliance with ARARs—Appendix A, Table A-1, describes how the ISB system will comply with the substantive portions of the regulatory requirements.

Table 3-1. Summary of ARARs for the hot spot remedy.

Requirement (Citation)	ARAR Type: Action Specific	ARAR Type: Chemical Specific	ARAR Type: Location Specific	Status: Deleted	Status: Unchanged	Remedy: Hot Spot	Comments
RCRA and Hazardous Waste Management Act							
Generator Standards IDAPA 58.01.05.006 (formerly IDAPA 16.01.05.006)	X				X		
Hazardous Waste Determination (40 CFR 262.11)	X				X	A	
General Facility Standards IDAPA 58.01.05.008 (formerly IDAPA 16.01.05.008)	X		X		X		
General Waste Analysis (40 CFR 264.13)	X				X	A	
Preparedness and Prevention (40 CFR Subpart C, 264.31–.37)	X				X	A	
Closure Performance Standard (40 CFR 264.111)	X				X	A	
Disposal/Decontamination (40 CFR 264.114)	X				X	A	
Use/Management of Containers (40 CFR 264, Subpart I)	X				X	A	
Land Disposal Restrictions (IDAPA 58.01.05.011 [formerly IDAPA 16.01.05.011])	X				X	A	
RCRA, Section 3020	X	X			X	A	
Underground Injection Control							
Idaho Rules for the Construction and Use of Injection Wells (IDAPA 37.03.03)	X	X			X	A	
Idaho Public Drinking Water							
MCLs (numerical standards only) (IDAPA 58.01.08.050.02 and .05 [formerly IDAPA 16.01.08.050.02 and .05])		X			X	R	
To-Be-Considered							
Radiation Protection of the Public and the Environment (DOE Order 5400.55)	X				X	A	Worker protection standard applies to workers only

Key: A = applicable requirement
R = relevant and appropriate requirement

4. REMEDIAL DESIGN

This section discusses the basis for and key aspects of the remedial design. A separate remedial design document, the "In Situ Bioremediation Remedial Design, Test Area North, Operable Unit 1-07B (Draft)" (DOE-ID 2002a), provides the design specifications, drawings, and supporting information.

4.1 Technical Basis

The technical basis identifies the operations and performance requirements necessary to prepare the ISB design. The requirements are established to bracket the key operating and monitoring parameters that are necessary for the ISB system to achieve the RAOs. The technical basis for the design consists primarily of the 3 years of operational data that have been collected during the field evaluation, predesign phases, and pre-design operations. The overall objective of this RD/RA process is to design and construct a cost-effective electron donor injection and monitoring system and to develop an efficient operating strategy that will meet or exceed the RAOs.

4.1.1 Problem Statement

A variety of liquid wastes and sludges were injected into approximately the upper 30 m (100 ft) of the Snake River Plain Aquifer (SRPA) at TAN using well TSF-05 for nearly 20 years ending in 1972. As a result of this injection history, a significant quantity of residual material remains in the vicinity of TSF-05. This residual material is commonly referred to as the "secondary source." The following subsections describe the hydrologic setting for the residual source area, the composition and distribution of the residual source material, and the chronology of events that lead up to the design of ISB.

4.1.1.1 Residual Source Area Hydrologic Setting—The aquifer in the vicinity of TSF-05 is somewhat less transmissive than the INEEL average. The site conceptual model indicates that transmissivities in this area range from about 38 m^2/day (409 ft^2/day) to 3,250 m^2/day (350,000 ft^2/day), as compared to an INEEL mean of about 8,640 m^2/day (93,000 ft^2/day) (USGS 1991). The hydraulic gradient near TSF-05 is approximately 0.0002 m/m to the east-southeast (EG&G 1994 and INEEL 1999a). The direction of groundwater flow and transport in the contaminated aquifer near TSF-05 is easterly and it appears to be governed by at least four key features. These features include: 1) recharge from the TSF-07, disposal pond, 2) pumping at the TAN production wells, 3) a general area of low hydraulic conductivity south of TSF-05 (discussed in INEEL 1996a and INEEL 1999b), and 4) the regional southerly gradient.

The velocity of groundwater throughout the plume is probably best estimated by the numerical model calibration to tritium transport. The average estimated groundwater velocity was about 0.15 m/day (0.49 ft/day) for most of the plume. This is consistent with an estimate of 0.13 m/day (0.43 ft/day) (EG&G 1994) based on evidence for the travel time from TSF-05 to USGS-24 during operation of the injection well. However, the model estimated a slower groundwater velocity of 0.073 m/day (0.24 ft/day) in the upgradient portion of the plume near the source area.

On the plume scale, the effective porosity of the aquifer has been estimated to be about 3%, again through numerical model calibration to the tritium plume (INEEL 1999). This value is about half that observed in a similar, large-scale characterization effort at the INEEL (INEEL 1997b), but like the comparatively low transmissible at TAN, this may be a result of the advanced age of the basalt. Not surprisingly, the effective porosity in the immediate vicinity of TSF-05 is much lower because of the well's injection history, as discussed in the next two sections.

4.1.1.2 Residual Source Composition—During the early groundwater characterization activities at TAN, it was found that sludge occupied the bottom 55 ft of the TSF-05 well casing (EG&G 1994). The sludge was removed from the well in 1990 and sampled. The analytical results for the constituents of greatest interest to this work are summarized in Table 4-1. TCE was measured at 30,000 mg/kg, or 3% by weight. While PCE and DCE were at lower concentrations than TCE, they were still significant contaminants. Also of interest are the concentrations of the radionuclides. Two gamma emitters, ^{60}Co and ^{137}Cs, were both present in the sludge at significant activity levels. Their presence was useful as a tracer of the sludge distribution.

Table 4-1. Contaminant concentrations in TSF-05 sludge from 1990 (EG&G 1994).

Contaminant	Concentration
TCE	30,000 mg/kg
PCE	2,800 mg/kg
1,2-DCE	410 mg/kg
^{60}Co	812 pCi/g
^{137}Cs	2,340 pCi/g
Tritium	1.03×10^{6} pCi/L

The high concentrations of tritium almost 20 years after use of the injection well ceased are particularly interesting considering that tritium should move freely through the subsurface as water. Tritium has never been measured outside of TSF-05 at concentrations greater than the drinking water standard of 20,000 pCi/L despite concentrations in the sludge almost two orders of magnitude higher. This disparity suggests that the tritium is trapped in the sludge pore water where advective groundwater flow is insignificant. Thus, tritium can only move downgradient after diffusing from the sludge pore water to the nearest advective flow path. This point is important because it must be true not only of tritium but also of all other contaminants in the sludge. Of course most other contaminants are also subject to sorption within the sludge, so their migration out of the sludge is further retarded. For the purpose of illustration, the sludge in the formation around the former injection well (TSF-05) can be thought of as a sponge saturated by the contaminants that are only very slowly released to groundwater flowing past.

4.1.1.3 Secondary Source Distribution—The sludge in the formation around TSF-05 is the secondary source that continues to contaminate groundwater at TAN. An important step in the characterization of the site for remediation is to estimate the distribution of the secondary source. For ISB to meet the RAOs, electron donor must be distributed throughout the volume of aquifer containing residual source material. The association of the gamma-emitters (^{60}CO and ^{137}Cs) with the sludge provides a means for using existing wells to estimate the residual source distribution. Downhole "natural" gamma and gamma spectroscopy logs were performed to establish the distributions of these radionuclides, using them as an indicator of the sludge distribution (INEEL 1998).

The gamma logging data illustrate several important points. First, they showed the spatial extent of elevated gamma activity (see Figure 4-1). Observed ^{60}Co and ^{137}Cs activity extended as far as well TAN-D2, about 35 m (115 ft) northwest of TSF-05. Logging of TAN-37, 40 m (130 ft) east of TSF-05, did not show elevated gamma activity. The second important result of these activities was the observation that the depths of elevated gamma activity correlated among the wells and with high porosity zones identified through seismic tomography (INEEL l998). This indicated that the layered geological structure did in fact result in preferential sub-horizontal flow paths for the sludge away from the injection well. Finally, it was observed that elevated gamma activity was only present to about 91 m (300 ft) bls, which is approximately the bottom of the TSF-05 injection interval. The residual source therefore appears to exist primarily in the upper 30 m (100 ft) of the aquifer.

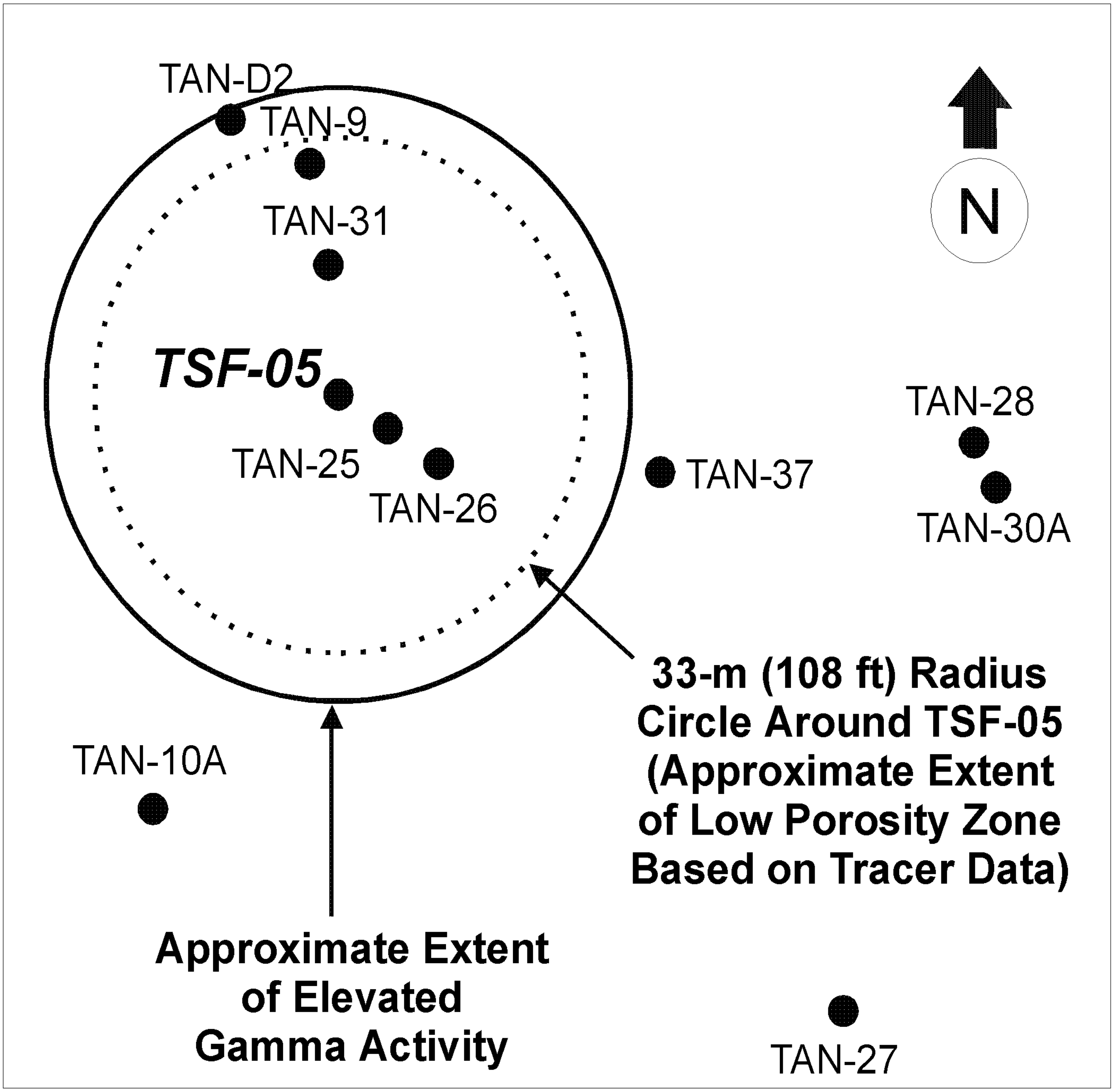

Figure 4-1. Approximate extent of the residual source around TSF-05.

The spatial extent of the sludge comprising the secondary source of contamination can also be estimated based on differences in the hydrologic properties of the aquifer in the vicinity of TSF-05. A numerical model of the TSF-05 area was developed through inverse modeling of multiple-well pumping tests (INEEL 1998). The effective porosity within about 20 m (66 ft) of TSF-05 was calibrated to range between less than 0.05 and 0.1%. The effective porosity in the bulk of the model domain was closer to 1%. The large reduction of effective porosity around TSF-05 is almost certainly a result of clogging of the formation by sludge (residual source material).

Finally, as part of the bioremediation field evaluation (Section 4.1.2.1), a diverging tracer test was performed (using TSF-05 as the injection point) that provided data useful for estimating the extent of the aquifer with reduced effective porosity due to the sludge. Two models were applied to the data to estimate effective porosity near TSF-05. Both models revealed very low effective porosities ranging from 0.04 to 0.1% within 15 m (50 ft) of TSF-05, and increasing porosities with distance (Sorenson 2000). These results are consistent with significant plugging of the formation with sludge near TS-05 that decreases with distance from the well. A "bull's-eye model" was developed to estimate the distance from TSF-05 at which the porosity transition occurs, and hence the radial extent of the sludge. Based on that simple model, the sludge extent was estimated to reach about 29 to 30 m (95 to 100 ft) from TSF-05 (see Figure 4-1) (Sorenson 2000).

4.1.1.4 Chronology of Events**—**In 1995, a ROD was written with a requirement to conduct treatability studies that focused on specific technologies that offered the potential to be more cost effective than the original remedy of pump-and-treat. These technologies included Metal Enhanced Reductive Dehalogenation, Monolithic Confinement (Grouting), ISB, In Situ Chemical Oxidation, and MNA. The treatability studies were concluded in 1999 and the results are summarized in the Field Demonstration Report (FDR) (DOE-ID 2000a). The FDR presented field monitoring data that demonstrated the ISB technology evaluation met or exceeded all objectives and expectations. The technical success of the field evaluation, combined with the preliminary cost information, supported a recommendation to implement ISB for remediation of the hot spot. Therefore, in 2001 a ROD Amendment was written that selected ISB to replace pump-and-treat for the hot spot area.

Beginning with the initial field evaluation, ISB activities leading up to this RAWP provide important information for implementing the final remedy. For purposes of this discussion, all of these activities are referred to as Predesign Operations. These activities are summarized in several documents, including: the *Field Evaluation Report of Enhanced In Situ Bioremediation, Test Area North, Operable Unit 1-07B* (INEEL 2000), the *Operable Unit 1-07B In Situ Bioremediation Annual Performance Report for October 1999 to July 2001* (INEEL 2002a), *Effects of Alternate Donors on an Enrichment Culture Capable of Complete Reductive Dechlorination (Draft)* (INEEL 2002b), and the *TAN OU 1-07B ISB Groundwater Model Development and Initial Performance Simulation* (INEEL 2002c).

4.1.2 Predesign Operations

In order to design a cost-effective, long-term bioremediation system for the hot spot, information was collected during Predesign Operations to address several key issues. These issues include:

- What electron donor should be used to stimulate anaerobic reductive dechlorination (ARD)
- How much electron donor should be added and how frequently should the electron donor be injected
- Where should the electron donor be injected
- At what rate should the electron donor be injected?

The field evaluation, together with the subsequent activities, provides over 3 years of experience to address these issues. This section summarizes the results of these operations in the context of the design issues. It also summarizes some additional laboratory studies and numerical modeling that contribute important insight for the design.

4.1.2.1 Field Evaluation—A field evaluation was conducted to determine whether degradation of TCE could be enhanced through the addition of an electron donor (lactate). The ISB field evaluation at TAN therefore entailed the weekly injection of high concentrations of an electron donor solution into well TSF-05 for a period of 8 months. In order to control the distribution of electron donor and nutrients in the subsurface, it was desirable to induce a hydraulic gradient through pumping. An extraction well was pumped continuously throughout the field evaluation to induce flow along the axis of the TCE plume, where the highest concentrations are present. The goal was to create an ARD treatment cell between well TSF-05 and the extraction well, TAN-29.

A start-up period was used to establish the baseline for relevant parameter distributions and to establish the baseline for flow and transport in the aquifer under the conditions of the field evaluation. Once the start-up period was completed and the necessary adjustments were made to the operations strategy, then electron donor addition and the groundwater monitoring to collect the data supporting the field evaluation objectives began.

The weekly injections of lactate during the field evaluation phase resulted in high concentrations of electron donor in source area and deep wells. Electron donor was present mainly in the form of propionate and acetate, which were present in a stoichiometric ratio greater than one, indicating significant lactate fermentation and some propionate fermentation. These high concentrations of electron donor resulted in the rapid depletion of competing electron acceptors; sulfate reduction was observed almost immediately and methanogenesis was observed in source area wells after approximately 4 months. Complete ARD of TCE to ethene was observed in source area wells coincident with the onset of methanogenesis. Electron donor was not distributed beyond the source area in the upper part of the aquifer and for this reason redox conditions remained only mildly reducing. Anaerobic reductive dechlorination was not observed in downgradient or wells more than 15 m (50 ft) crossgradient (INEEL 2002a).

The field evaluation demonstrated that complete reductive dechlorination of TCE to ethene could be achieved through electron donor addition. Furthermore, the process resulted in accelerated mass transfer of TCE from the secondary source, which may shorten the overall remedial time frame relative to the default remedy, pump and treat.

Following the field evaluation, new objectives were identified and broken down into PDP-I, PDP-II, and PDO. These data were then used to develop a plan for long-term implementation of enhanced ISB at the TAN hot spot.

4.1.2.2 PDP-I—PDP-I was established to determine the persistence of electron donor and ARD reactions once lactate injections were discontinued, and to evaluate the efficiency of ARD reactions in the prolonged presence of electron donors other than lactate. Lactate injection was discontinued while changes in the treatment cell were monitored. Operations consisted simply of monitoring biogeochemical changes for a period of 4 months and monitoring VOCs throughout the treatment cell.

When lactate injections were discontinued during PDP-I, electron donor concentrations throughout the source area decreased rapidly. At the same time, the propionate:acetate decreased, as propionate fermentation was the dominant electron donor utilization process. Electron donor in deep wells began a slow decline. Redox conditions remained methanogenic in the source area and deep wells and conditions in downgradient wells became more reducing. The efficiency of ARD reactions increased during this time, as indicated by the complete depletion of TCE and increase in ethene concentrations (INEEL 2002a).

Data collected indicated that the efficiency of ARD reactions increased when propionate and acetate, rather than lactate, were available as the only electron donors. For this reason, the lactate injection strategy was changed from that used during the ISB field evaluation such that larger volumes of lactate were injected on a much less frequent basis (bimonthly rather than weekly). The increased injection volume caused the electron donor solution to be pushed farther out into the treatment cell. The injection of lactate resulted in rapid fermentation to propionate and acetate that were then utilized much more slowly than lactate. The infrequent injection of lactate allowed the more slowly utilized propionate and acetate to be the dominant electron donors within the treatment cell, favoring more efficient ARD.

4.1.2.3 PDP-II—PDP-II, which began in January 2000 and continued through April 2001, was established to:

- Determine the effect of renewed lactate injection, after approximately 4 months without lactate injection, on ARD efficiency and redox conditions throughout the treatment cell. The treatment cell is defined as the biostimulated aquifer volume of enhanced ARD.
- Optimize lactate addition (quantity and frequency) based on data collected from PDP-I.
- Monitor concentrations of regulated substances in electron donor stock solutions.

When lactate injections were resumed on a bimonthly basis in PDP-II, electron donor concentrations and the propionate:acetate ratio increased in source area wells with each injection, while deep wells remained unaffected. Source area wells remained methanogenic; however, conditions in downgradient wells became less reducing. Anaerobic reductive dechlorination continued in source area wells while a slight rebound in TCE and depletion of ethene in downgradient wells indicated that the areal extent of ARD reactions had decreased since lactate injections were renewed during PDP-II.

The data collected indicated that the efficient ARD observed in PDP-I was maintained during PDP-II in most of the residual source area. It also showed that the efficiency at the downgradient edge of residual source had decreased somewhat, apparently because of incomplete electron donor delivery to this area. The downgradient portion of the residual source area required better lactate distribution.

The electron donor product used during PDP-II was monitored for regulated substances and had the lowest trace metal concentrations measured to date and met all requirements. Concerns about EPA Target Analyte List (TAL) metals in sodium lactate have been addressed by requiring analysis of each new source and product type.

4.1.2.4 Predesign Operations—The results of PDP-I and -II were used to define the specific approach to be used to meet the following objectives for PDO:

- Continue to operate the ISB system to contain and degrade the OU 1-07B hotspot
- Maximize cost-effectiveness of TCE dechlorination
- Optimize sampling frequency and location
- Determine whether lactate injection results in mobilization of metals, strontium, and/or semivolatile organic compounds (SVOCs) from the secondary source
- Determine how to distribute electron donor better within the upper part of the aquifer.

These objectives were met as follows:

- The ISB system continued to contain and degrade the hotspot, as evidenced by TCE concentrations near non-detect in hotspot wells. Trans-DCE was observed to be more recalcitrant to degradation; however, concentrations are approximately equivalent to MCLs at the end of the treatment cell and decrease downgradient because of attenuation and dispersion.

- The PDO injection strategy resulted in propionate fermentation conditions preferred for efficient ARD in source area wells. The downgradient secondary source area shows incomplete dechlorination. Alternate injection strategies are required to optimize dechlorination in the downgradient residual source area.

- The sampling strategy was refined based on results to date. Fewer locations are monitored for source mobilization parameters; analytes and sampling frequency are reduced overall. Current strategy cost-effectively meets all requirements.

- No significant mobilization of metals or SVOCs was observed. Only ^{90}Sr appears to be mobilized in the immediate source area; however, lactate injection results in no significant mobilization of ^{90}Sr, metals, or SVOCs outside the ISB treatment cell.

- The current injection strategy maintains adequate electron donor in the upper aquifer in most of the secondary source area. However, alternate injection locations and strategies to achieve this goal in the downgradient residual source area are required to distribute electron donor between TAN-25 and TAN-37.

4.1.2.5 Numerical Modeling—Numerical modeling was recently performed to evaluate two model scenarios to assist in designing an optimum remediation strategy (INEEL 2002c). Scenario 1 was designed to inject the same mass of lactate at TSF-05 as during PDP-II but with about twice the volume of water. In other words, the injected lactate concentration was about half that of the PDP-II injections. Scenario 2 involved injection at a hypothetical well just west of TAN-37 simultaneously with injection at TSF-05. The purpose of Scenario 2 was to gain insight into methods of distributing the electron donor over a much larger area. The model results indicated that a higher volume lactate injection causes a distribution similar to that resulting from previous injections, while using two injection wells offers a much better donor distribution than a single injection well.

4.1.2.6 Laboratory Studies—During FY-01 and FY-02, a laboratory study was performed to determine the effectiveness of other readily available, lower-cost carbon sources, specifically whey and molasses (INEEL 2002b). These sources could potentially stimulate microbial dechlorination of TCE similarly to lactate. This study assessed the effectiveness of whey and two different grades of molasses by utilizing them in fed-batch reactor studies in which dechlorination daughter products and organic acids were measured. The data were then used to evaluate dechlorination efficiencies of the various electron donors.

The study revealed that lactate stimulated the most rapid complete dechlorination. After lactate, whey showed the next best efficiency, followed by food grade molasses. The feed grade molasses was the only carbon source that did not facilitate dechlorination of TCE and PCE.

4.1.2.7 Summary of Important Topics—The following list summarizes the hydrologic setting for the secondary source area and its composition and distribution, as described above:

1. The SRPA has transmissivities ranging from about 38 m^2/day (409 ft^2/day) to 3,250 m^2/day (350,000 ft^2/day)

2. The direction of groundwater flow and transport in the contaminated aquifer near TSF-05 is easterly

3. The hydraulic gradient near TSF-05 is approximately 0.0002 m/m to the east-southeast

4. The estimated groundwater velocity is 0.073 m/day (0.24 ft/day) in the upgradient portion of the plume near the source area

5. Modeling of pumping and tracer test results revealed very low effective porosities ranging from 0.04 to 0.1% within 15 m (50 ft) of TSF-05, and increasing porosities with distance

6. The residual source appears to exist primarily in the upper 30 m (100 ft) of the aquifer and the extent of the sludge was estimated to be about 29 to 30 m (95 to 100 ft) radially from TSF-05.

The following list summarizes the information collected during PDO that will aid in designing a cost-effective, long-term bioremediation system for the hot spot:

1. **What electron donor should be used to stimulate ARD?** Field results indicate that lactate is an effective electron donor. Laboratory studies performed to test alternate electron donor revealed that lactate stimulated the most rapid complete dechlorination. After lactate, whey showed the next best efficiency, followed by food grade molasses. Additional work will be required to determine the most cost-effective of these or other potential electron donors.

2. **How much electron donor should be added and how frequently should the electron donor be injected?** The electron donor injection strategy for long-term operations should consist of larger volumes of lactate injected on a much less frequent basis than weekly (i.e., monthly or bimonthly). Numerical modeling suggests that higher volume, lower concentration lactate injections are about the same as the PDP-II injections in terms of electron donor distribution. If another electron donor is used, then the volume, concentration, and frequency will need to be reestablished.

3. **Where should the electron donor be injected?** Field results indicate that alternative injection strategies to deliver electron donor to the outside edge of the secondary source area are required. Numerical modeling suggests that at least one additional injection location is necessary to provide adequate electron donor distribution to the downgradient portion of the residual source area

4. **At what rate should the electron donor be injected?** PDO activities did not include an evaluation of different electron donor injection rates; however, current rates appear to be adequate.

All of the information described in this section was utilized to establish the TFRs for the ISB electron donor system.

4.2 Technical and Functional Requirements

The specific requirements for the ISB amendment addition system are located in TFR-2539, "Technical And Functional Requirements for the In Situ Bioremediation Design at TAN, OU 1-07B." In general, the ISB electron donor addition system will be comprised of equipment and controls needed to properly inject an electron donor within the OU 1-07B hot spot area. This ISB system, working in conjunction with naturally occurring organisms, is designed to degrade the secondary source within the hot spot and stop contaminants from leaving the hot spot. The ISB system will add amendment to the current injection location (TSF-05) but will be capable of expanding to other injection locations. These additional injection locations may be existing wells or new wells. New wells will be installed in incremental stages and will only be installed when deemed necessary through project review of operational data. The ISB system will mix the amendment with potable water and inject the mixture into any of the existing or new injection wells.

The design requirements used are as listed:

- In order to perform year-round operations/injections, storage for the amendment to prevent physical, chemical, or biological degradation must be provided. The amendment must also be brought to its operating temperature prior to mixing. Proper heating, ventilation, and air conditioning (HVAC) is required to maintain adequate working conditions year-round for operators in the ISB manual injection system.

- ISB groundwater monitoring must be capable of detecting changes in the subsurface plume to determine the adequacy of the source containment and its removal. Figure 4-2 identifies the existing monitoring wells plus the locations of two potential new monitoring wells (PMW-1 and PMW-2). As with any new injection wells, the new monitoring wells would be installed in incremental stages and will only be installed when deemed necessary through project review of operational data.

- The ISB system will require a field sample analysis laboratory equipped with the proper instruments to perform several real-time field analyses of groundwater samples taken as part of the ISB monitoring process.

- The ISB system will be designed to operate for 15 years in order to meet the RAOs for the hot spot remediation, as defined by the ROD Amendment (DOE-ID 2001a). The ISB system's primary operations include, but are not limited to:

  - Staging an adequate supply of amendment

  - Pumping the amendment into the distribution system

  - Monitoring the distribution of amendment

  - Monitoring the performance of ISB with respect to meeting regulatory requirements.

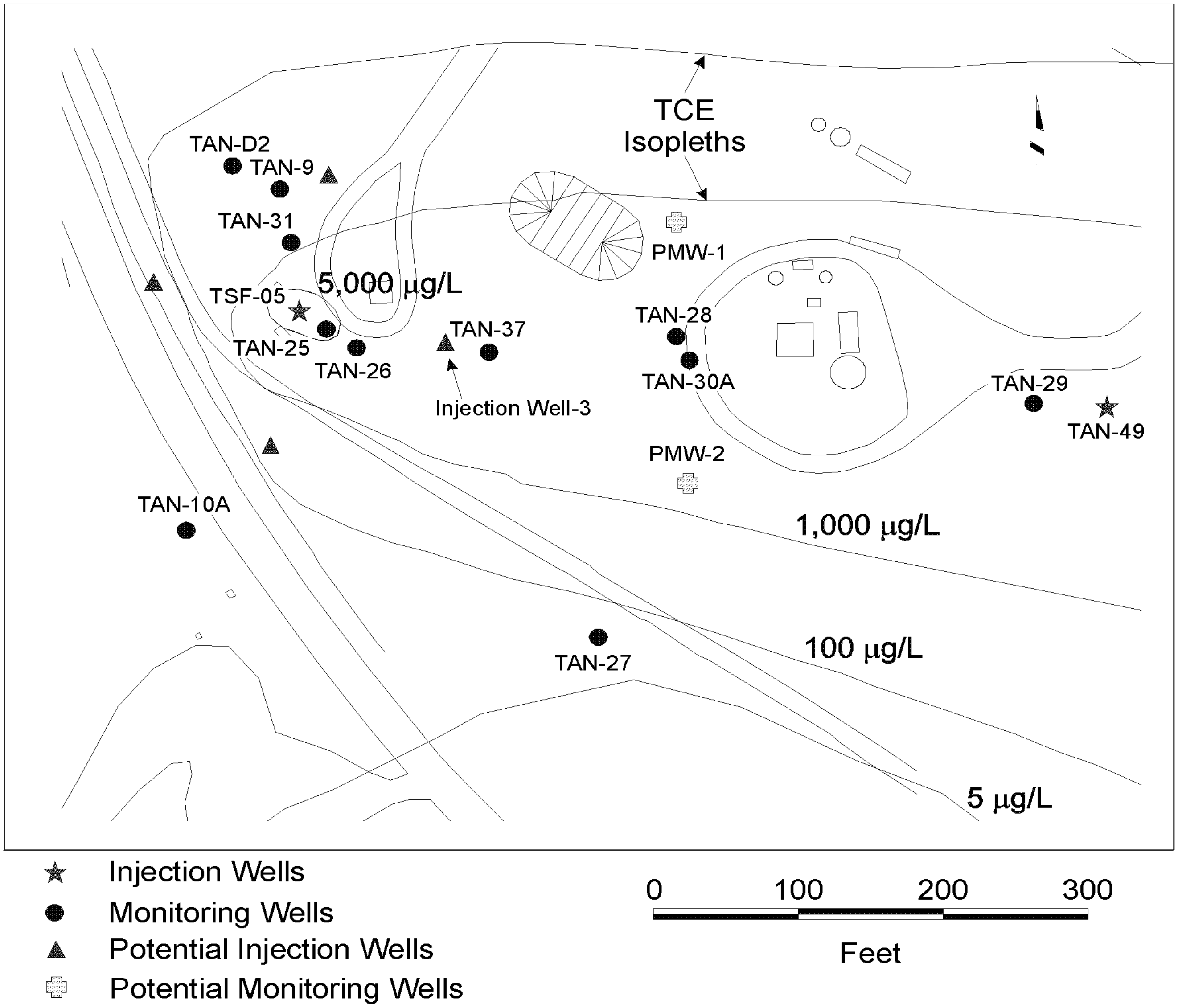

Figure 4-2. Hot spot vicinity map.

The following are ISB system assumptions:

- Multiple injection locations will be required in order to obtain an effective amendment distribution
- Water and electric utilities will be available but sewer and communications services will not
- Support personnel (e.g., crafts, Industrial Hygiene, and Radiological Control Technicians) will be available to support ISB long-term operations.

4.3 Infrastructure Design Alternatives

This section discusses the facility design options available to the project resulting from the completion of the ISB TFRs. The previous section summarized the ISB hot spot TFRs and assumptions; TFR-2539 provides a complete breakdown of the recommended TFRs. These requirements and assumptions have lead to the development of several alternative strategies for design and construction of the ISB hot spot facility. These alternatives were developed to consider and compare the capital and long-term operations costs and identify the most desirable alternative that maximizes ISB effectiveness while maintaining project schedule, quality, and cost objectives.

Initially, more than a dozen alternatives were identified that considered such items as facility size, location, storage capability, field lab space, number of injection wells, type of electron donor, and the use of existing facilities. The minimum capability requirements for all of the alternatives are:

- 3 injection wells
- Injection in one well at a time
- Lactate, molasses, and whey handling capability.

Following the review of these alternatives with the agencies and further internal analysis, the alternative list was narrowed to seven and is presented in Table 4-2. As a result of further reviews and discussions with the agencies, alternative C was chosen for implementation of ISB at the hot spot. Table 4-3 is a comparison of the seven alternatives considering capital construction cost. The comparison is of facility construction and long-term operation cost for lactate versus whey powder for each alternative. For both lactate and whey powder, the ROD Cost Estimate Net Present Value before contingency is used as the base cost.

Alternative C features the minimum requirements listed above and includes space in the new facility for a field laboratory and field personnel office space. The more expensive alternatives were ruled out because it is currently believed that the capability to simultaneously inject in multiple wells will not be a requirement, and therefore the cost of sizing a facility to store sufficient amendment and piping to multiple wells can be avoided. Less expensive alternatives (other than alternate C) were eliminated due to the long-term nature of the project (a minimum design life of 15 years). The less expensive alternatives relied on utilizing trailers or existing TAN facility buildings for storage, lab space, and office space. TAN facilities are scheduled for decontamination and decommissioning (D&D) beginning in FY-03. OU 1-07B personnel will not be able to use existing TAN facilities after that time. Based upon the uncertainty of the TAN mission and the potential costly maintenance costs for trailers and temporary facilities, these alternatives were ruled out.

4.4 ISB Infrastructure Design

This section presents a summary discussion of the ISB hot spot design. A much more detailed discussion of this design, including drawings, specifications, and justifications, is provided in the "In Situ Bioremediation Remedial Design, Test Area North, Operable Unit 1-07B (Draft)" (DOE-ID 2002a). The new facility is located adjacent to the existing groundwater treatment facility just downgradient from the hot spot (see Figure 4-3). This section focuses on the two primary components: the process facility and the laboratory facility.

Table 4-2. Alternative evaluation for design and construction of the ISB Hot Spot Facility.

Alternatives	Cost (support facilities)	Cost (wells)	# inject. wells	# of simultaneos injections	Whey powder	Molasses/ Sodium lactate	Heated nutrient storage	Office	Rest rooms	Lab	Lab Equip. Storage (ft^2)	Sampling equip. storage (ft^2)	Year-round injections	Bldg	Piping	Simultaneous injections (potable water)	Whey powder	Molasses/ Sodium lactate	Rest rooms	Trailer	Tanker delivery
A) 2400 ft^2 (60' x 40') 5 injection wells 3 simultaneous injectors Molasses/Lactate/ Whey New Laboratory/Office	$634k	$450k	5	3	x	x	36 275 gal. Totes/ 36 2000 lb. Sacks	x	x	x	250	180	x	414	79	22	61	41	17	0	0
** **Minimum requirements** 3 injection wells 1 injection well only Molasses/Lactate/ Whey			3	1	x	x	20 275 gal. Totes/ 20 2000 lb. Sacks	(1)	(1)	(1)	0	0	x								
A*) 2400 ft^2 (60' x 40') 3 injection wells 1 simultaneous injectors Molasses/Lactate/ Whey New Laboratory/Office	$582k	$150k	3	1	x	x	36 275 gal. Totes/ 36 2000 lb. Sacks	x	x	x	250	180	x	414	49	0	61	41	17	0	0
C) 1200 ft^2 (40' x 30') 3 injection wells 1 injection well only Molasses/Lactate/ Whey New Laboratory/Office	$380k	$150k	3	1	x	x	20 275 gal. Totes/ 20 2000 lb. Sacks	x	x	x	0	100	x	212	49	0	61	41	17	0	0
E) 800 ft^2 (40' x 20') 3 injection wells 1 simultaneous injectors Molasses/Lactate/ Whey Trailer for Office/Lab	$304k	$150k	3	1	x	x	20 275 gal. Totes/ 20 2000 lb. Sacks	(1)	(1)	(1)	0	100	x	145	27	0	61	41	0	30	0

Table 4-2. (Cont'd).

Alternatives	Cost (support facilities)	Cost (wells)	# inject. wells	# of simultaneos injections	Whey powder	Molasses/ Sodium lactate	Heated nutrient storage	Office	Rest rooms	Lab	Lab Equip. Storage (ft^2)	Sampling equip. storage (ft^2)	Year-round injections	Bldg	Piping	Simultaneous injections (potable water)	Whey powder	Molasses/ Sodium lactate	Rest rooms	Trailer	Tanker delivery
G) 400 ft^2 (20' x 20') 1 40'x10' Seavans (new) 3 injection wells 1 injection well only Molasses/Lactate/ Whey Trailer for Office/Lab	$286k	$150k	3	1	x	x	36 275 gal. Totes/ 36 2000 lb. Sacks	(1)	(1)	(1)	0	0	x	127	27	0	61	41	0	30	0
N) Seavan (existing) 3 injection wells 1 injection well only Molasses/Lactate TAN-607 for Office/Lab	$167k	$150k	3	1		x		x	x	x			(2)	60	49	0	0	41	17	0	x
O) Seavan (existing) 3 injection wells 1 injection well only Molasses/Lactate Trailer for Office/Lab	$68k	$150k	3	1		x		(1)		(1)	0	0	(2)	0	27	0	0	41	0	0	x

(1) = Located in trailer
(2) = Heated tanker

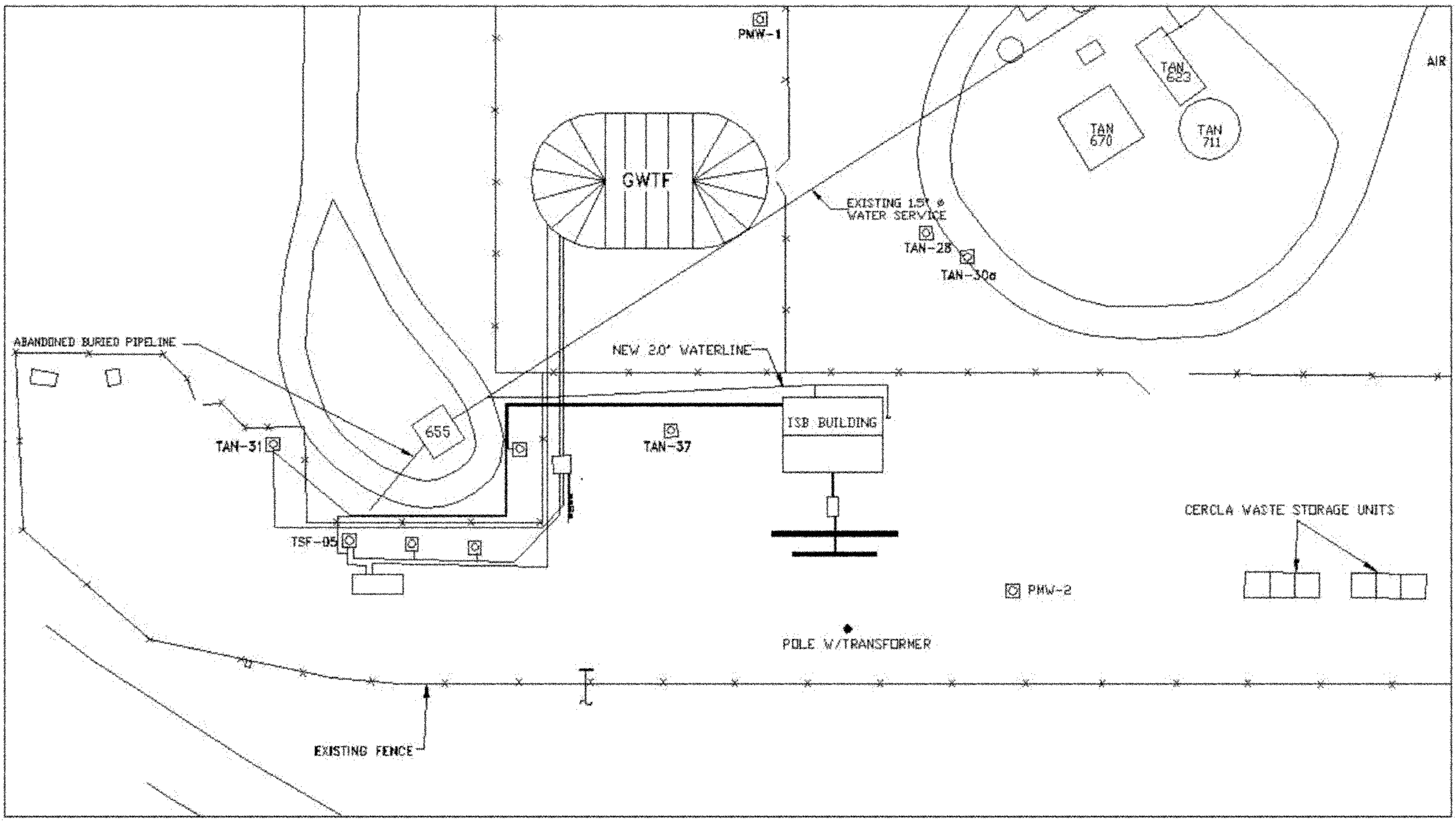

Figure 4-3. ISB facility site area layout.

Table 4-3. ROD Amendment cost comparison.

	Net Project Cost (Lactate)		Net Project Cost (Whey Powder)	
	NPV	Difference[a]	NPV	Difference[a]
Original	$35,414,898[b]	$ -	$35,414,898[a]	$ -
Alternate A	$35,926,485	$511,587	$35,651,301	$236,403
Alternate A*	$35,877,785	$462,887	$35,602,601	$187,703
Alternate C	$35,687,031	$272,133	$35,411,847	$(3,051)
Alternate E	$35,615,230	$200,332	$35,340,046	$(74,852)
Alternate G	$35,598,232	$183,334	$35,323,049	$(91,849)
Alternate N	$35,485,890	$70,992	N/A	N/A
Alternate O	$35,392,370	$(22,528)	N/A	N/A

a. Relative difference of each alternative from the ROD Cost Estimate. The difference is in net present value (NPV).
b. ROD Cost Estimate for amended remedy in net present value before contingency.

4.4.1 Process Facility

The process facility is a 30 × 40-ft pre-fab building set onto a slab-on-grade concrete base (see Figure 4-4). Within the facility are distinct areas for nutrient storage (500 ft^2), process equipment (300 ft^2), a field laboratory (250 ft^2), and office space (150 ft^2). A 15-ft-wide roll-up delivery door provides direct access to the nutrient storage area, while an 8-ft-wide roll-up door provides easy access for off-load of used totes, supersacks, and pallets to the external storage pad during injection events. This building will be situated within the CERCLA Waste Storage Area, which is southeast of well TAN-37. This location will facilitate quarterly delivery of palletized amendments, as well as minimize the amount of trenched piping required for solution delivery to the injection wells. Amendment solution can be injected into one of the three injection wells located within 100 ft of TSF-05 (TSF-05, TAN-31, and Injection Well 3). The equipment used in this process is located in the process equipment area of the process facility and includes potable water piping, amendment injection devices (i.e., pump for molasses and lactate, bulk bag unloader, and eductor for lactose powder), flow monitoring devices (pressure gauges and flow meters), flow control valves, and solution injection piping that runs from the process facility to each injection well (see Figure 4-5).

4.4.2 Laboratory Facility

The ISB Remedial Design plan view of the process facility shown in Figure 4-4 includes a field laboratory that will allow groundwater analyses to be performed on-site. This laboratory will house all the equipment required for groundwater sampling support, such as a water deionization apparatus, storage refrigerators and freezers, waste carboys and tanks, a fume hood with an acid counter, a sink, at least 30 ft of counter space, a desk and PC, and equipment storage cabinets.

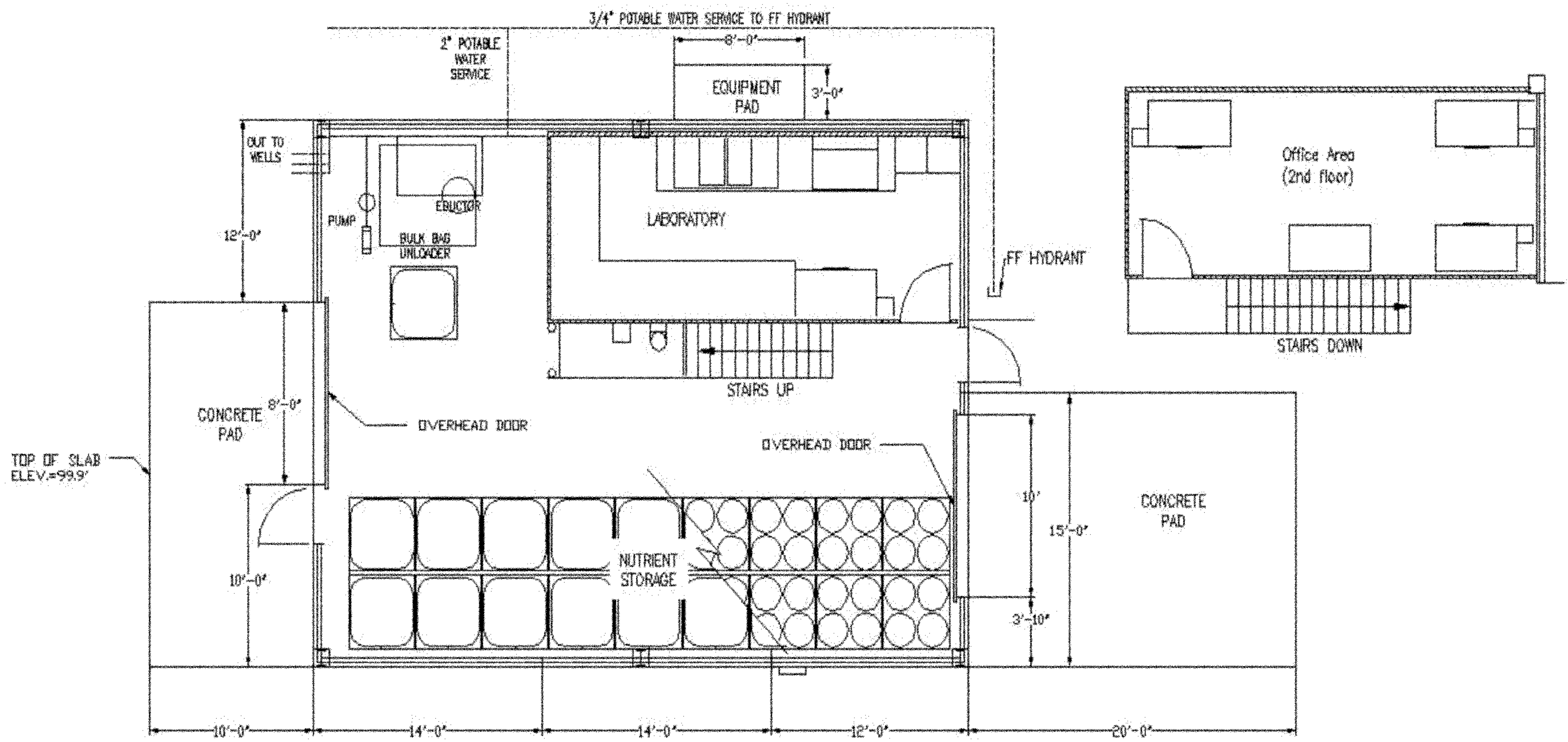

Figure 4-4. Process facility layout drawing.

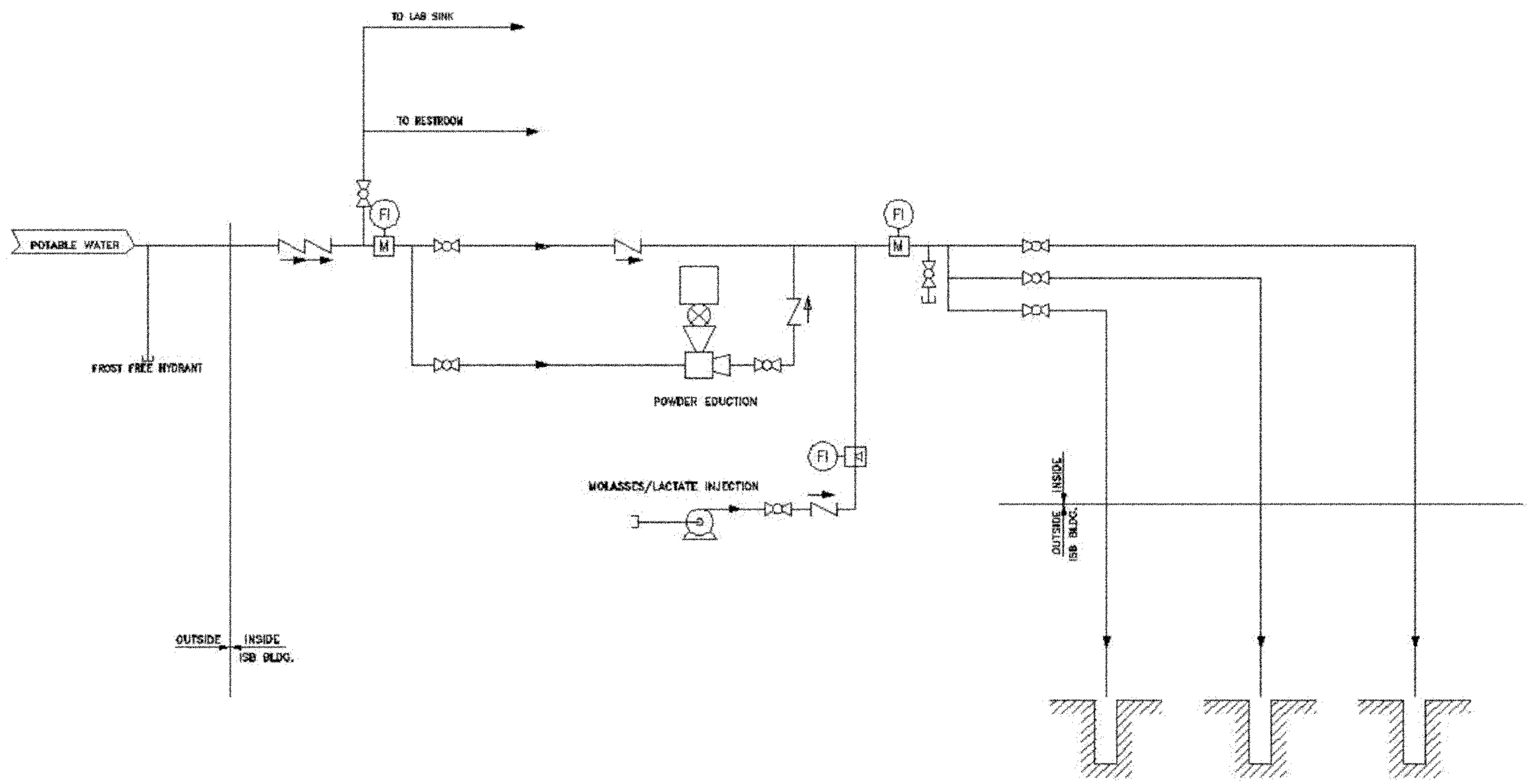

Figure 4-5. Process flow diagram for ISB.

5. INTERIM OPERATIONS

This section addresses the requirements for the interim operations period of ISB operations. Interim operations are the period between the approval of this RAWP and the start of initial operations, which will start with the completion of construction of the new ISB injection facility. Interim operations will be a continuation of the pre-design operational activities and will cover activities that support a better understanding of alternate amendment, development of injection and monitoring strategies that support initial operations, ISB model refinement, and continued ISB lactate addition. The *In Situ Bioremediation Operations and Maintenance Plan for Test Area North, Operable Unit 1-07B* (DOE-ID 2002b) and *Groundwater Monitoring Plan for the Test Area North Operable Unit 1-07B ISB Remedial Action* (INEEL 2002d) will govern the implementation of interim operations.

5.1 Scale-up Studies for Alternate Amendments

Two alternate amendments have been identified that may be as effective as lactate, at a much lower cost. Additional information is needed to determine if these donors are viable candidates for replacing sodium lactate. A series of scale-up studies are planned to take these donors from bench-scale to field scale. An electron donor scale-up studies work plan will be developed that details an objective approach to determine if these (or other) alternate donors can replace sodium lactate.

5.2 Injection Strategy Testing to Support Initial Operations

During interim operations, injection and monitoring strategies will be implemented that will help determine the ISB systems initial operations configuration. Field studies will be performed to determine required quantities, locations, frequency, and rates of injection and will be supported by monitoring and analysis.

5.3 ISB Numerical Model Refinement

A numerical model has been developed for ISB using field data from current and previous years. This model has been tested with several simulations and was used to support ISB design assumptions. Yearly updates to the model, based on operational data, are planned. The updated model will be used both to evaluate various potential improvements to the electron donor injection strategy and to support analysis of performance monitoring data. Following refinement during the interim operations period, the model will be used to support the first ISB Annual Report, which incorporates new data each year.

5.4 Continued Sodium Lactate Addition

This activity consists of continued operation and maintenance (O&M) of the current ISB system, including groundwater monitoring and injection strategy evaluations.

6. FACILITY CONSTRUCTION

This section addresses the procurement, construction, and agency acceptance of the new ISB hot spot injection facility. This includes organization, subcontracting plans, construction, construction close-out, system operational testing, and agency inspections and acceptance.

6.1 Organization

The organizational structure of this remedial action must be flexible in order to handle the maturing and changing nature of the project as it goes from cradle to grave. Initially, the project will be undergoing construction and numerous operational and monitoring requirement changes as the project moves to achieve long-term operations. Throughout this period, the agencies and the project team will be exploring methods to maximize operational efficiency, including determining the best electron donor type, quantity, injection rate, concentration, and a host of other operational and monitoring parameters. As the remedial action proceeds through operational phases, it should reach a fairly routine operational state requiring only minor modification to the operational strategy and monitoring requirements.

Throughout the project, the DOE-ID project remediation manager will be responsible for notifying the EPA and IDEQ of project activities, and will serve as the single interface point for all routine contacts between the agencies and the management and operating (M&O) contractor. The M&O contractor shall be responsible for implementation of the remedial action from cradle to grave. This includes design, field activities, waste management, health and safety, quality assurance, and all other tasks necessary for the completion of this remedial action. The *Test Area North Operable Unit 1-07B Final Groundwater Remedial Action Health and Safety Plan* (INEEL 2002e) includes the near-term project organizational chart and a role and responsibility description. This organizational chart covers operations up through at least the initial operations phase of the project and may be adjusted from time to time, as circumstances dictate.

6.2 Subcontracting Plan

Short-term construction activities will be accomplished primarily through subcontracting. To the largest extent practicable, the work will be combined into a single bid package that will be competitively bid and awarded as a firm, fixed-price contract to the lowest price qualified bidder (subcontractor). The request for proposal will specify, among other things, a strict period of performance, which will correspond with the overall project schedule.

6.3 Construction

The construction work for this remedial action consists of four primary components, as follows:

- Process facility enclosure—A steel building with a concrete foundation capable of housing the process system, nutrient storage, and field laboratory
- Process system—A process system shall be installed that is capable of injecting electron donor within the parameters specified in the ISB TFRs
- Injection and monitoring wells—Injection and monitoring wells will be installed in accordance with project plans and specifications
- Field laboratory—A field laboratory shall be installed that provides the capability of analyzing the parameters specified in the ISB GWMP (INEEL 2002d).

Section 4 provides a more detailed discussion of these components. The construction work will be implemented through five stages, as follows:

- Premobilization—This period of time shall be utilized to prepare the subcontractor, site personnel, and support personnel for facility construction. This will include submittal and approval of vendor data, subcontractor work plans, bonds, insurance certifications, and other necessary contractual requirements.

- Mobilization—This period of time will be used to prepare for construction activities. This work generally includes the implementation of required administrative and engineering controls. These include health and safety controls, fences, signs and postings, demarcation of contamination and decontamination zones, establishing lay-down areas and staging areas, delivery and storage of construction materials and equipment, and set-up of field offices.

- Construction—This period covers the installation of the four primary components.

- Construction Completion and Closeout—Upon completion of the construction, the subcontractor and contractor shall perform a facility walkdown and develop a punch list to record deficient items. The walkdown will also include a test of individual components to determine that they were constructed and operate in accordance with design specifications. The subcontractor shall be given a limited amount of time to correct deficient items.

- Demobilization—After construction activities and inspections have been satisfactorily completed and all equipment is properly decontaminated and cleaned, the subcontractor will demobilize from the construction site.

6.4 Start-up and Operational Testing

System operational testing will be performed on all system components to ensure that the equipment has been properly installed and operates in accordance with the design specifications. System operational testing will be performed in accordance with written start-up and test procedures. The required procedures are identified in the ISB O&M Plan (DOE-ID 2002b).

Concurrent with operational testing, the M&O Contractor will conduct a management self-assessment of the facility and of the facility's operational readiness. This will include a review of procedures, training, and other items necessary to safely operate the system.

6.5 Agency Inspections and Acceptance

Upon completion of construction activities, the new ISB facility shall be subject to agency inspections, as described in the following sections. After inspections are completed, a report will be prepared to document any issues identified during the inspection and the proposed corrective action. Upon agency acceptance of the facility, ISB initial operations shall proceed as specified in Table 2-1.

6.6.1 Pre-final Inspection

The pre-final inspection shall be conducted by the agencies' project managers (or their designees) at the completion of construction activities. A pre-final inspection checklist shall be prepared and agreed to by the agencies prior to performing the inspection. Open items will be recorded during the pre-final inspection and an action will be identified to resolve the open items. At the end of the inspections, the agencies will determine which open items require closure prior to proceeding with treatment systems operation. Upon acceptance of the pre-final inspection report, initial operations may begin.

6.6.2 Pre-final inspection report

A pre-final inspection report will be prepared to document the results of the pre-final inspection. The report will identify the open items from the inspection, the agreed upon action for closing the open items, and the scheduled closure date for each open item. The pre-final inspection report will be prepared as a secondary document for review by the agencies. The pre-final inspection report will include the following:

- Completed pre-final inspection checklist
- Identification of open items
- Actions and schedules for closure of open items
- Planned date for final inspection (if required).

6.6.3 Final Inspection

If required, a final inspection shall be performed at the completion of initial operations, as defined in Section 2-2. This inspection will focus on the performance of the ISB system at meeting the objectives of the initial operational period. Upon acceptance of the final inspection report, optimization operations will begin.

6.6.4 Final Inspection Report

A final inspection report shall be prepared to document the results of the initial operations period. This report shall address the following:

- Results of the final inspection
- Evaluation of the effectiveness in meeting treatment system performance and compliance objectives
- Resolution of any outstanding items from the pre-final inspection
- Explanation of any changes from the remedial design and RAWP
- Concurrence that the remedy should proceed into optimization operations
- An O&M Plan (DOE-ID 2002b) update, if necessary.

6.6.5 Remedial Action Report

At the completion of the ISB optimization operations phase, a remedial action report will be prepared. The requirements for this report are discussed in Section 7 and further detailed in the ISB O&M Plan (DOE-ID 2002b). The completion of optimization operations should lead to a determination through the remedial action report that ISB at the hot spot is operational, functional, and ready to move into long-term operations.

7. OPERATIONS AND MAINTENANCE

This section of the ISB RAWP identifies the requirements for operating and maintaining the ISB facility and supporting infrastructure. It also provides the requirements, goals, and objectives for the ISB O&M Plan (DOE-ID 2002b). As described in Section 4, the ISB facility consists of a building and process equipment for injection of electron donor to facilitate ARD of the secondary source and VOCs within the hot spot. The facility also consists of supporting infrastructure including a field lab, a monitoring well array, sampling tools and equipment, the CERCLA Waste Storage Unit (CWSU), and utilities.

This section of the RAWP addresses:

- The operational strategy leading to long-term operations
- Resources needed to support implementation of this operational strategy
- Operations, procedures, and protocols
- Performance and compliance monitoring data analysis and interpretation
- Operational decision making
- Institutional controls
- Remedy performance review and reporting.

An ISB O&M Plan (DOE-ID 2002b) has been prepared to implement the requirements of this section.

7.1 Operational Approach

A phased implementation strategy is planned for the OU 1-07B ISB remedial component. The planned implementation strategy provides a sequenced approach designed to show measurable progress toward attainment of the compliance and performance objectives.

7.1.1 Interim Operations

Interim operations are the period between the approval of this RAWP and the start of initial operations. Interim operations will be a continuation of the pre-design operational activities and will cover activities that support a better understanding of alternate electron donors, development of injection monitoring strategies that support initial operations, ISB model refinement, and continued ISB electron donor addition. Section 5 of this RAWP details the basis and requirements for interim operations.

7.1.2 Initial Operations

Initial operations will start with the completion of the construction of the new ISB injection facility, as signified by the completion of the agency pre-final inspection. Initial operations are planned to occur during the first 2 years following completion of interim operations. During this time, various injection strategies will be used to determine the best method to reduce the downgradient, axial flux from the hot spot such that VOC concentrations will be reduced to less than MCLs in TAN-28 and -30A. Periodic performance monitoring at designated wells will be conducted as groundwater monitoring, as discussed in Section 8. Initial operations will be complete when the VOC concentrations are below the MCLs at TAN-28 and –30A for a period of 1 year.

7.1.3 Optimization Operations

Optimization operations are planned to occur during the 5 years following completion of initial operations. During this time, various injection strategies will be used to reduce the crossgradient and maintain downgradient flux of VOCs such that concentrations are below MCLs at PMW-1 and PMW-2. Periodic performance monitoring at designated wells will be conducted as discussed in Sections 2 and 8. Optimization operations will be complete when the VOC concentrations remain below the MCLs at PMW-1 and PMW-2 for a period of 1 year.

7.1.4 Long-Term Operations

Long-term operations will begin following completion of optimization operations and will focus on achievement of hot spot source degradation, while maintaining the reduction of flux from the hot spot in the downgradient and crossgradient directions.

7.2 Operational Resources

Operational resources required to implement the remedial action strategy include both personnel resources and physical infrastructure resources. This section describes the basis and requirements for the organization of personnel (including roles and responsibilities), the physical facilities, and the equipment required for operations.

7.2.1 Organization

The personnel requirements for supporting ISB must include a combination of management, technical, and field resources with the knowledge and capabilities to implement ISB. This includes recognized capabilities for:

- Conducting work in accordance with the ROD and this RAWP (within CERCLA regulations) and in compliance with the INEEL site work control requirements
- Managing and conducting groundwater monitoring
- Managing, operating, and maintaining ISB injection and support facilities
- Administrating and conducting field lab work
- Managing, coordinating, and implementing sample management
- Reviewing and interpreting ISB data
- Recommending operational changes.

7.2.2 ISB Facilities and Equipment

The ISB injection system shall be operated and maintained so that it meets the requirements of TFR-2539, "Technical and Functional Requirements for the In Situ Bioremediation Design at TAN, OU 1-07B," this RAWP, and the ROD (DOE-ID 1999). Monitoring wells shall be provided that meet the needs of the ISB performance and compliance monitoring strategy (see Section 2). These wells shall be maintained so that ISB performance and compliance monitoring can be performed in accordance with the requirements of the ISB GWMP (INEEL 2002d). Additional monitoring or injection wells may be installed to meet the needs of the project. A field analysis lab that has the capability to analyze for the constituents required by the ISB GWMP shall be operated and maintained.

7.3 Operations Procedures and Protocols

Operational procedures and protocols shall be developed as part of the O&M Plan that govern and guide the implementation of ISB remedial action activities. These procedures and protocols shall be prepared so that requirements defined by site work control, the ISB RAWP, the ISB GWMP, the O&M Plan, and ARARs are met. The following facilities, operations, and activities shall have procedures and protocols developed:

- ISB facility operations
- Groundwater monitoring
- Hydrolab operations
- Field lab operations
- Well maintenance
- Sample management
- Data management.

7.4 Data Analysis and Interpretation

Data analysis and interpretation is critical to the success of the ISB remedial component. Clear performance and compliance goals have been developed and a phased implementation approach is planned. Data analysis and interpretation and reporting will provide the means for the project and the agencies to make decisions regarding ISB performance and compliance and to determine whether operational changes are required to operate ISB more effectively and efficiently. The ISB O&M Plan (DOE-ID 2002b) provides the plan for data analysis and interpretation that will clearly determine progress of ISB toward the performance, compliance, and completion measures identified in Section 2. Figure 7-1 provides the flow and interface between groundwater monitoring activities (the GWMP) and operations and maintenance (the O&M Plan).

7.5 Operational Decision Making

The phased implementation approach allows the flexibility to modify the operating and monitoring strategy to implement ISB more effectively and efficiently. Inherent in the review and interpretation of performance and compliance data is the opportunity to change injection strategies through the modification of flow rate, quantity, concentration, or injection location. Each phase of the implementation strategy should progressively become more effective and efficient as a result of these changes. The ISB O&M Plan shall include a section that will identify the basis for making routine and non-routine operational decisions.

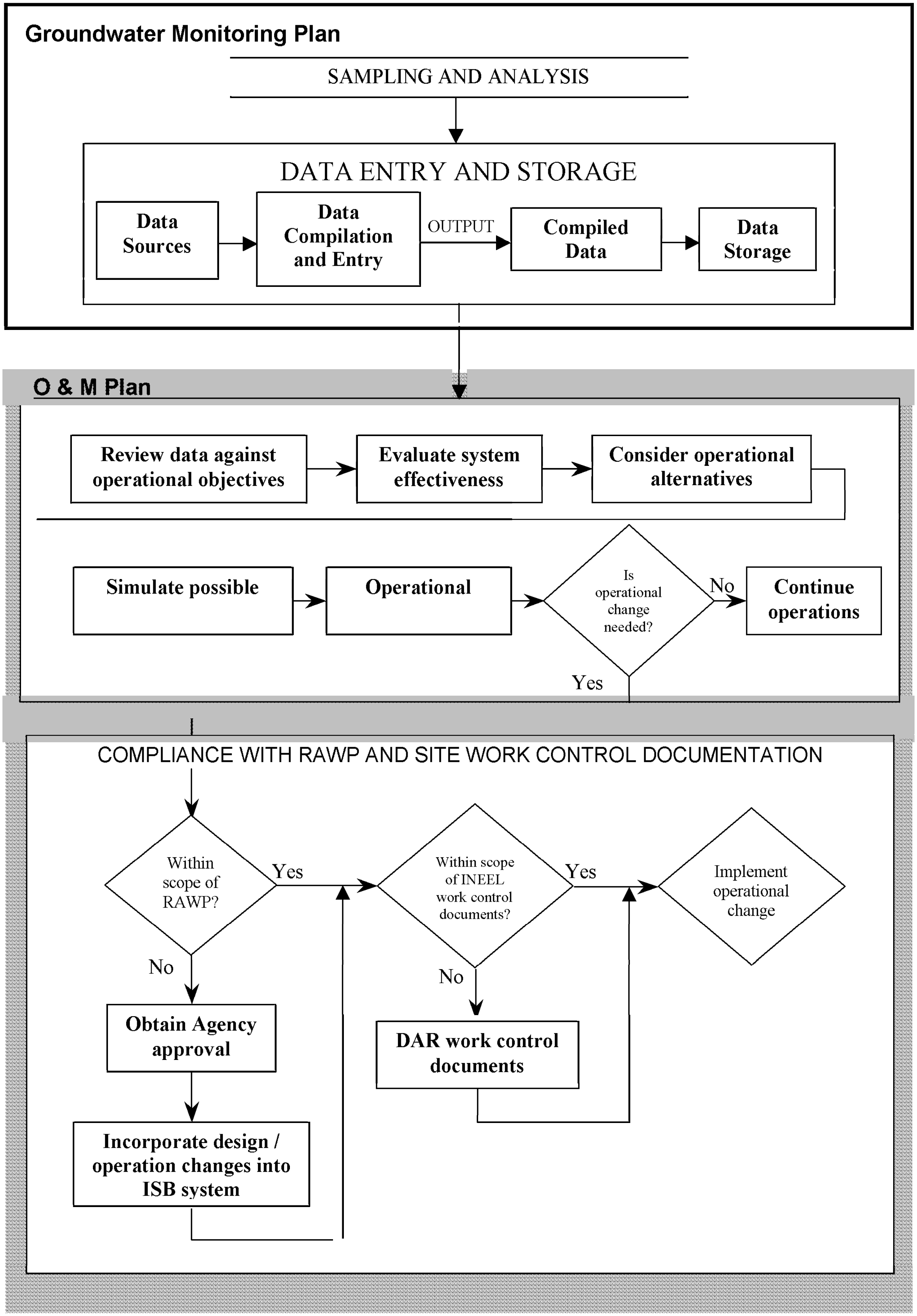

Figure 7-1. Flow and interface between the GWMP and the O&M Plan.

7.6 Institutional Controls

Institutional controls shall be implemented to prevent the use of contaminated groundwater until the RAOs specified in Section 2 have been attained throughout all areas of the contaminated aquifer. Institutional controls shall consist of engineering and administrative controls to protect current and future users from health risks associated with groundwater contamination. The institutional controls will prevent ingestion of contaminated groundwater. Institutional controls for OU 1-07B have been addressed in the OU 1-10 ROD (DOE-ID 1999 [DOE/ID-10682]). These controls include visible restrictions, control of activities, control of well drilling, and control of land use. The ISB O&M Plan shall address ISB-specific institutional controls.

7.7 Remedy Performance Review and Reporting

Reporting requirements for ISB are derived from the need to review the performance and compliance of ISB on a periodic basis, and to judge the combined effect of ISB and the other remedial action components toward achieving total plume restoration. There are three reporting requirements identified for ISB. These requirements include a remedial action report, periodic performance and compliance reports, and remedy performance summary reports.

7.7.1 Pre-Final Inspection Report

As specified in the OU 1-07B RD/RA SOW, a pre-final inspection will be conducted at the completion of ISB construction activities. A Pre-Final Inspection Report will be generated as a result of this inspection. The enforceable date for this inspection is March 2004. The Pre-Final Inspection Report will include the following:

- Inspection checklist
- Discussion of findings
- Outstanding remedial action requirements
- Corrective Action Plans
- RAWP and O&M Plan update
- Final inspection date.

7.7.2 Remedial Action Report

As specified in the OU 1-07B RD/RA SOW (DOE-ID 2001b), a remedial action report will be prepared for the ISB system. This report will be prepared at the completion of the optimization operations after the system has been deemed operational and functional. The remedial action report will be a primary document and a milestone completion date will be established in the pre-final inspection or final inspection report.

The remedial action report discusses as-built conditions and the reasons for any changes, and discusses and memorializes operational testing, shakedown operations, and final inspections. Evaluating effectiveness of the remedy and other topics will result in a determination of whether the remedial action can be determined to be operational and functional. This remedial action report will identify a schedule for the modification of the ISB O&M Plan to define any operational changes resulting from optimization operations, and detail the requirements for determining completion of ISB at the hot spot.

7.7.3 Periodic Performance and Compliance Report

This periodic report will summarize the data gathered for a specific remedial component through a specified period, will provide trending information, and will discuss operational changes and modifications. This report will be summarized, along with the other remedial components, in the annual remedy performance summary report.

The objectives of the periodic report are to evaluate progress of the remedial component toward achievement of its performance, compliance, and completion requirements.

This will include:

- Performance parameter trends
- Compliance parameter trends
- Data interpretation
- Completion evaluations
- Operational summary
- Operational recommendations.

7.7.4 Remedy Performance Summary Reports

The objective of the remedy performance summary report is to show periodic progress of the entire remedial action toward achievement of meeting RAOs. This report is a roll-up of each remedial component's periodic report and will summarize each remedial component's progress towards achieving compliance and performance objectives for a specified period and will discuss and/or recommend operational changes and modifications for the period. It will also show how the remedial components are working together to remediate the entire contaminant plume.

8. GROUNDWATER MONITORING

This section of the ISB RAWP identifies the requirements, and the basis for the requirements, for ISB groundwater monitoring. The groundwater monitoring requirements are derived from the RAOs and performance goals defined in the ROD Amendment (DOE-ID 2001a) through the DQO process. The output of the DQO process is a groundwater monitoring strategy designed to assess progress toward, and completion of, the RAOs and performance goals. Section 2 of this RAWP defines the performance and compliance objectives necessary to show achievement of the RAOs.

Data collected through groundwater monitoring will be used specifically to assess performance of the remedy, determine the need for operational changes, and support agency performance and compliance reviews. This section of the RAWP covers:

- Data quality objectives
- Monitoring strategy
- Data collection
- Sample management and analysis
- Data management and reporting.

A GWMP (INEEL 2002d) has been prepared to implement the requirements of this section.

In addition to providing data for evaluation of ISB performance and compliance objectives, the ISB groundwater monitoring program shall also provide data for the evaluation of two other remedial action monitoring requirements; these two requirements govern the monitoring of radionuclides. The first is the RAO requirement that all COCs (radionuclides included) be below MCLs by 2095; this is a requirement and objective of MNA. The second monitoring requirement is to provide data to evaluate the migration of radionuclides from the source area into the medial zone. This data will be used to satisfy the NPTF PM/CM requirement for medial zone source control.

8.1 Data Quality Objectives

Data quality objectives for the ISB component of the remedy are based on the following: 1) decision types requiring groundwater monitoring data, 2) EPA DQO guidance (EPA QA/G-4 1994), 3) method detection limits, and 4) experience with the sampling and analysis methods to date. Requirements for data quality for all INEEL CERCLA investigations and remedial responses are defined in the *Quality Assurance Project Plan (QAPjP) for Waste Area Groups 1, 2, 3, 4, 5, 6, 7 and 10* (DOE-ID 2000b). Appendix B contains the ISB DQO development process.

Decisions requiring groundwater monitoring data are based on the RAOs and performance objectives for the ISB component of the remedy. These decisions are listed below:

1. Determine whether operational changes are required by routinely monitoring the performance of the ISB system with respect to indicator parameters, including VOCs, tritium, ethene/ethane/methane, redox parameters, electron donor, bioactivity, and nutrients.
2. Determine whether downgradient flux of contaminants from the hotspot has been cut off, as evidenced by VOC concentrations below MCLs at TAN-28 and -30A.
3. Determine whether crossgradient flux of contaminants from the hotspot has been cut off, as evidenced by VOC concentrations below MCLs at PMW-1 and PMW-2.

4. Determine whether long-term operations are complete (the compliance criteria for long-term operations will be specified in the ISB Remedial Action Report).

The result of the DQO development to support these decisions is the monitoring strategy described below. A detailed discussion of DQO development along with a discussion of specific indicator parameters (compliance and performance) is provided in Appendix B.

8.2 Monitoring Strategy

The monitoring strategy incorporates the results of the DQO process described in Appendix B, as well as experience gained in 4 years of ISB field evaluation and pre-design operations. The ISB remedial action implementation strategy shown in Figure 2-1 is divided into the following four operational phases: 1) interim operations, 2) initial operations, 3) optimization, and 4) long-term operations. With the exception of interim operations, two monitoring components (i.e., performance and compliance) are defined for each operational phase.

The performance and compliance monitoring strategies created to support the implementation strategy are summarized in Tables 8-1 and 8-2, respectively, and are described below. Monitoring locations, analytes, sampling frequencies, and data quality requirements for each phase of operations and monitoring are defined and detailed in the ISB GWMP (INEEL 2002d). Definition of data quality requirements includes analytical methods, action levels, and detection limits for all analytes and phases of monitoring.

The overall OU 1-07B ISB remedial action sampling strategy to support the decisions listed in Section 8.1 is as follows:

- **Interim operations performance monitoring** (Decision 1): Includes monthly sampling for performance indicator parameters at all 15 existing ISB locations for the duration of the phase.
- **Initial operations performance monitoring** (Decision 1): Includes monthly sampling for performance indicator parameters at all 15 ISB locations, including new monitoring wells PMW-1 and PMW-2, for the duration of the phase. This strategy includes monitoring for VOCs at TAN-28 and TAN-30A to determine downgradient contaminant flux trends.
- **Initial operations compliance monitoring** (Decision 2): The strategy for determining when downgradient flux of VOCs from the hot spot is cut off includes quarterly monitoring for 1 year at TAN-28 and TAN-30A for VOCs. This sampling will begin when performance monitoring indicates that VOC concentrations are below MCLs at TAN-28 and TAN-30A.
- **Optimization operations performance monitoring** (Decision 1): Includes monthly sampling for performance indicator parameters at all 15 ISB locations, including new monitoring wells PMW-1 and PMW-2, for the duration of the phase. The monthly sampling frequency will be continued to identify trends requiring operational modifications. This strategy includes monitoring for VOCs at PMW-1 and PMW-2 to determine crossgradient contaminant flux trends.
- **Optimization operations compliance monitoring** (Decision 3): The strategy for determining when crossgradient flux of VOCs from the hotspot is cut off is quarterly monitoring for 1 year at PMW-1 and PMW-2 for VOCs. This sampling will begin when compliance monitoring indicates that VOC concentrations are below MCLs at PMW-1 and PMW-2.

Table 8-1. ISB remedial action groundwater performance monitoring strategy summary.

Monitoring Type/strategy element	Operational Phase			
	Interim	Initial	Optimization	Long-term
Decision number	1			
Monitoring duration	Duration of phase			
Monitoring frequency	Monthly[a]			Quarterly[a]
Monitoring locations	TSF-05A, TSF-05B, TAN-10A, TAN-25, TAN-26, TAN-28, TAN-29, TAN-30A, TAN-31, TAN-37A, TAN-37B, TAN-37C, and TAN-D2.	TSF-05A, TSF-05B, TAN-10A, TAN-25, TAN-26, TAN-28, TAN-29, TAN-30A, TAN-31, TAN-37A, TAN-37B, TAN-37C, and TAN-D2, PMW-1, PMW-2		
Analytes	VOCs (PCE, TCE, cis- and trans-DCE, vinyl chloride), electron donors (COD, lactate, acetate, propionate, butyrate), redox parameters (ferrous iron, sulfate), bioactivity parameters (alkalinity), dissolved gases (ethene, ethane, methane), and radionuclides (Cs-137 and Sr-90 (NPTF/MNA source area PM parameters identified in Table 2-2) and tritium).			
Data quality required[b]	Screening w/definitive confirmation for VOCs Screening for all other analytes			
Data validation level required[c]	Level A for chloroethene definitive confirmation and radionuclide analyses No data validation for on-site and IRC laboratory data			

a: Includes semiannual nutrient analyses and annual definitive confirmation for VOCs
b: Data quality levels are defined in the QAPjP.
c: Data validation levels are defined in the QAPjP.

Table 8-2. ISB remedial action groundwater compliance monitoring strategy summary.

Monitoring Type/strategy element	Operational Phase			
	Interim	Initial	Optimization	Long-term
Decision	N/A	2	3	4
Monitoring duration	N/A	1 year		TBD
Monitoring frequency	N/A	Quarterly		TBD
Monitoring locations	N/A	TAN-28 TAN-30A	PMW-1 PMW-2	TBD
Analytes	N/A	VOCs (PCE, TCE, cis- and trans-DCE, vinyl chloride)		TBD
Data quality required[a]	N/A	Definitive		TBD
Data validation level required[b]	N/A	Level A		TBD

a: Data quality levels are defined in the QAPjP.
b: Data validation levels are defined in the QAPjP.
N/A: Not applicable
TBD: To be determined

- **Long-term operations performance monitoring** (Decision 1): Includes quarterly sampling for performance indicator parameters at all 15 ISB locations, including new monitoring wells PMW-1 and PMW-2, for the duration of the phase. The ISB system will be functional and operational during this phase (with a defined operating strategy) and therefore, will result in reduced performance sampling requirements. The number of monitoring locations and analytes may also be reduced during this phase.

- **Long-term operations compliance monitoring** (Decision 4): The sampling strategy for determining when the remedy is complete will be defined in the remedial action report.

8.3 Sampling Equipment and Procedures

The sampling equipment and procedures required to support the monitoring strategy are detailed in the ISB GWMP (INEEL 2002d). Sampling procedures identify the equipment and techniques necessary to implement required sampling. These procedures, which address training, equipment, instrument calibrations, purging, sampling, purge water management, decontamination and cleaning of equipment, and record keeping in support of the monitoring plan, will be updated as required for the duration of monitoring. Multiparameter water quality sensors may be used for collecting purge parameter data during sampling, and for in situ deployment in wells for the duration of the remedy implementation. Multi-level sampling may be performed and FLUTe liners may be installed in wells TAN-37, PMW-1, and PMW-2 as part of remedy implementation. All waste materials (e.g., PPE, bottles, rinsates, and purge waters) generated as a result of sampling activities will be managed in accordance with the *Waste Management Plan for TAN Final Groundwater Remediation OU 1-07B* (INEEL 2001a).

OU 1-07B ISB well information is maintained in the OU 1-07B project files and in the INEEL Hydrologic Data Repository (HDR). Information includes well names and aliases, locations, construction diagrams, material types, depths, screened or open intervals, discharge hose or pipe dimensions, sampling depths, maintenance history, and other information. Well maintenance and water level measurement activities, both of which contribute to the OU 1-07B Groundwater Monitoring Program, will be performed as described in the ISB O&M Plan (DOE-ID 2002b).

8.4 Sample Management and Analysis

The ISB groundwater monitoring program consists of the three following analytical components: 1) onsite analyses and measurements, 2) sample analysis performed at the INEEL Research Center (IRC), and 3) sample analysis performed at offsite laboratories. This section identifies the requirements of the sample management and analysis strategies. Figure 7-1 is a flow chart that describes the interface between groundwater monitoring and O&M. This figure shows the relationship between the collection and analysis of samples and data interpretation.

8.4.1 Sample Management

A sample management plan shall be instituted that manages, tracks, and stores data collected as part of the groundwater monitoring program. This plan shall have an orderly sample identification, designation, and tracking system that tracks samples from collection through shipping, analysis, and interpretation and into long-term data storage. A sample management procedure shall be developed that provides clear direction regarding sample management throughout the life of the project.

8.4.2 Sample Analysis

Sample analysis will be conducted using three analytical components (i.e., the on-site field laboratory, the IRC laboratory, and the sample management office-appointed off-site laboratories) dependent upon holding time restrictions, analytical capabilities, and quality level requirements. Analytes and analytical methods to be used for each of the three components shall be defined in the ISB GWMP (INEEL 2002d) and ancillary procedures. Equipment and procedures consistent with the analytical method requirements will be employed for each analytical component. Quality assurance requirements specific for each of the three components are described in the ISB GWMP.

8.4.2.1 On-site Field Laboratory Activities—The field laboratory supports all ISB project team activities for all three analytical components of the monitoring program. The field laboratory is the center for all on-site data collection activities, including field test kits, in situ hydrolab data, and purge data. These activities provide near real-time data for evaluation of the performance of the ISB remedy. In addition, the field laboratory is used to coordinate sample delivery to the IRC and sample shipment to off-site laboratories. Specific activities that the field laboratory supports include field test kit analyses; gross alpha-beta counts; sample packing and shipping; hydrolab deployment, maintenance, calibration, and downloading; sample bottle preparation; and administrative activities.

8.4.2.2 IRC Laboratory Activities— Analysts at the IRC laboratories determine VOCs, ethene/ethane/methane, and volatile organic acids using the methods described in the ISB GWMP and ancillary procedures. The ISB GWMP identifies all other analytical methods as well as procedures and protocols for implementing the monitoring strategy.

8.4.2.3 Off-site Laboratory Activities—Off-site laboratories determine contaminant concentrations using methods appropriate for definitive data. The methods used by off-site laboratories are specified in the ISB GWMP (INEEL 2002d).

8.5 Data Management

The O&M section of this RAWP outlines the requirements and the ISB O&M Plan describes in more detail the data management plan for this project. This will be the process used by the project to enter, manipulate, evaluate, and archive data generated during implementation of the ISB remedy. Figure 7-1 is a flow chart that describes the interface between groundwater monitoring and O&M. This figure shows the relationship between the collection and analysis of samples and data interpretation.

9. DECONTAMINATION AND DECOMMISSIONING

Decontamination is a process whereby contaminants that have accumulated on or in equipment, tools, or treatment systems are removed or neutralized such that they no longer present a hazard to human health or the environment. Decontamination efforts associated with OU 1-07B have been grouped into two activities. These two activities include: 1) those that are involved with day-to-day operations and investigations (i.e., interim decontamination) and 2) those that are associated with the final shut down and decommissioning of any treatment facilities used to remediate the OU (i.e., final decontamination).

9.1 Interim Decontamination

Detailed procedures for decontamination can be found in the *Interim Decontamination Plan for OU 1-07B* (INEEL 2001b).

Decontamination of the tanks, containers, and equipment used for the remedial actions associated with OU 1-07B involves removal and disposal of waste present in the containers and decontamination of the interiors of tanks, containers, and associated ancillary equipment in contact with waste, as necessary. Decontamination consists of rinsing the item to be decontaminated with water to meet the performance criteria in the Interim Decontamination Plan (INEEL 2001b). Spent decontamination water and other liquid waste streams generated during the decontamination process will be evaluated against OU 1-07B Waste Management Plan (WMP) criteria. Where appropriate, those streams that are compatible will be transferred to the NPTF for processing with the surge tank contents. Those waste streams that are not compatible with NPTF operations will be sampled and analyzed for characterization in accordance with the WMP (INEEL 2001a).

9.2 Final Decontamination and Decommissioning

Final D&D of OU 1-07B treatment systems will be addressed after the agencies determine that the active remediation is complete and/or that the treatment systems are no longer required. The D&D requirements for each treatment system will be addressed in future D&D plans. In general, the D&D plans will direct that, for the facilities built to remediate OU 1-07B, all tanks, containers, piping, and equipment be flushed with clean water to remove as much contamination as possible. The system will be dismantled and made ready for decontamination as directed by management. Components that can be decontaminated will be released for use in other systems, or disposed as industrial waste. The site will be returned to its pre-operation condition to the extent feasible considering cost and intended future use.

The wells that are placed in the area will continue to be used for monitoring of the aquifer, or will be abandoned in accordance with INEEL procedures. Other equipment and facilities installed during the remediation activities will be dismantled, decontaminated, and disposed in accordance with INEEL policy and procedures.

The OU 1-07B CWSU adjoining the hot spot site will be left “as-is” for storage as needed. The waste stored within will be processed and disposed as addressed in the WMP (INEEL 2001a). These CWSUs may be moved to other locations if the need arises.

10. WASTE MANAGEMENT

All waste generated during ISB will be managed in accordance with the provisions of the WMP (INEEL 2001a). Equipment and material decontamination requirements and procedures are specified in the Interim Decontamination Plan (INEEL 2001b). All of the materials to be used in the nutrient addition system are nonhazardous. Any waste generated from operations of the nutrient addition system will be managed and disposed of as nonhazardous solid waste.

All waste generated during the OU 1-07B remedial action will be managed and disposed of in accordance with applicable waste management requirements, including those contained in the *Waste Certification Plan for the Environmental Restoration Program* (INEEL 1996b) and the *INEEL Reusable Property, Recyclable Materials, and Waste Acceptance Criteria* (DOE-ID 1997). All waste management activities will be conducted in accordance with the applicable substantive requirements of the Resource Conservation and Recovery Act (RCRA).

Specific waste management regulatory issues that are applicable to OU 1-07B are summarized in the following sections. These include:

- RCRA-listed waste
- Toxic Substance and Control Act (TSCA)-regulated waste
- Low-level radioactive waste.

10.1 Resource Conservation and Recovery Act Listed Waste

10.1.1 Listed Waste Determination

The TSF-05 injection well was drilled in 1953 to a depth of 93 m (310 ft) to dispose of liquid effluent generated from the Aircraft Nuclear Propulsion project. Discharges to the well included organic sludges, treated sanitary sewage, process wastewater, and low-level radioactive waste streams. The principal VOC discharged was TCE. Estimates of the volume of TCE discharged to the well range from 1,325 to 97,161 L (350 to 25,670 gal). Previous evaluations of the solvents used at TAN concluded that the waste discharged to the injection well was not an RCRA-listed hazardous waste because the organic chemicals in the waste were not used as solvents, or for degreasing, and because the actual usage practices were not known (DOE-ID 1995).

In April 1997, based on new information, it was determined that a RCRA-listed solvent (TCE) was disposed at the TAN Facility via the TSF-21 valve pit. Since the valve pit is connected with the TSF-05 injection well, the injection well and associated groundwater contamination plume are considered to contain RCRA-listed waste. The RCRA-listed waste classification, waste code F001, is therefore applicable to the TCE-contaminated TAN groundwater and associated waste streams, and the substantive requirements of the ARARs are applicable for the RCRA-listed waste (INEEL 1997a). The listed waste determination was implemented for OU 1-07B for waste that was not previously determined to be characteristic based on the OU 1-07B Waste Management Compliance Commitments and Schedule dated July 22, 1997. This was concurred with by the agencies per a DOE letter from K. E. Hain (ER Restoration Program Manager) to K. L. Falconer (Director of ER) dated August 29, 1997.[a]

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a. Letter from K.E. Hain (DOE-ID), Manager of Environmental Restoration Program, to K. L. Falconer (INEEL), Director of Environmental Restoration, DOE-ID Letter OPE-ER-129-97, August 29, 1997.

10.1.2 No-Longer Contained-In Determination

Environmental media are considered to potentially contain RCRA-listed hazardous waste if there was a release to the media that included these wastes (40 CFR 261.3). Of the options available to manage waste containing low to non-detectable concentrations of listed waste, a no-longer contained-in determination (NLCID) may be requested for these environmental media, soil, and groundwater. Until a NLCID is made for the OU 1-07B waste streams, the media will be managed as a listed hazardous CERCLA waste in accordance with the WMP (INEEL 2001a). The NLCIDs that have been approved are attached to the WMP (INEEL 2001a).

10.1.3 ISB Sampling Purge Water

Due to this listed waste determination, all water extracted from the OU 1-07B groundwater plume must be handled in such a way as to meet the substantive requirements of the ARARs for RCRA-listed waste. As part of the ISB remedial component, routine groundwater sampling occurs producing significant quantities of purge water. This purge water shall be collected throughout sampling activities and processed through the NPTF. The NPTF air and water effluent discharge requirements remain the same for the purge water as with routine NPTF extraction well water.

10.2 Toxic Substances Control Act Regulated Waste

In the 1950s, the V-Tanks were installed to store liquid radioactive waste generated at TAN prior to treatment. Liquid wastes were pumped to these tanks from the TSF laboratories and craft shops, hot and warm shops, a radioactive decontamination shop, hot cells, and the Initial Engine Test Facility. In 1968, approximately 227 L (60 gal) of oil was discovered in Tank V-2, reportedly from a spill of hydraulic oil in the hot cell. This oil was subsequently removed in 1981 and sampled. The analysis of the oil revealed polychlorinated biphenyl (PCB) (Aroclor 1260) concentrations up to 680 mg/kg.[b] The PCBs have been identified in all three tanks with maximum concentrations of 660 mg/kg in V-1, 260 mg/kg in V-2, and 400 mg/kg in V-3 (see Footnote b). The V-tanks have not been used since the early 1980s. Treatment for the liquid radioactive waste, when the V-tank system was in operation, consisted of processing the liquid waste through the evaporator in TAN-616 (and later the PW-2 system) to concentrate the radioactive waste. The wastewater from the evaporator system was discharged to the warm waste system and then to TSF-05.

Recent sampling events at TSF-05 have shown that the PCB concentration in the sludge at the bottom of the well is 6 mg/kg. Since this is less than the 50 mg/kg addressed in 40 CFR 761, the waste generated during the remedial actions at OU 1-07B will be managed as not containing PCBs until such time as sampling shows that the sludge in TSF-05 has PCB concentrations of 50 mg/kg.

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b. Letter from Carlos Tellez (INEEL), Director of Environmental Affairs, to Dan Duncan (EPA), TSCA Program Manager, INEEL Letter CLT-84-97, September 3, 1997.

11. EMERGENCY RESPONSE

Emergency response is covered by the *INEEL Emergency Action (EA)/RCRA Contingency Plan Addendum for TAN Facilities* (INEEL 1997c). The TAN OU 1-07B Health and Safety Plan (HASP) (INEEL 2002e) contains primary emergency response actions for OU 1-07B site personnel, including initial responses, task site responsibilities, emergency equipment at the task site, emergency response teams, and notification lists. This section of the HASP supplements the INEEL EA/RCRA Contingency Plan. Copies of both of these documents are kept in the OU 1-07B office located in Building TAN 607. A copy of the HASP will also be kept in the hazardous communications center located at the OU 1-07B remediation site.

The INEEL EA/RCRA Contingency Plan (INEEL 1997c) includes emergency response organizations and operational emergency event classes for the following:

- Fires
- Explosions
- Radiological releases
- Nonradiological releases
- Natural phenomena
- Loss of power
- Criticalities
- Safeguards and security
- External events.

Sections 5 through 14 of the contingency plan address notifications and communications, consequence assessment, protective actions, medical support, recovery and reentry, public information, emergency facilities, training (in the OU 1-07B HASP), drills and exercises, and program administration. The INEEL EA/RCRA Contingency Plan contains OU 1-07B Appendix "L4," which is specific to the OU 1-07B project and defines specific measures and criteria used for OU 1-07B activities.

Emergency actions are primarily governed by the HASP; however, when emergencies result that are beyond the limitations of the HASP, the INEEL EA/RCRA Contingency Plan will be implemented. Therefore, in the event of an emergency, initial responders shall follow the direction of the HASP unless the resulting emergency is designated as a fire, explosion, or an uncontrolled release to the environment, in which case the INEEL EA/RCRA Contingency Plan will be implemented.

12. QUALITY ASSURANCE PROGRAM

This RAWP is intended to be used in conjunction with the QAPjP (DOE-ID 2000b) and PLN-694, "Environmental Restoration Project Management Plan, for Environmental Restoration and Decontamination and Decommissioning Projects."

The most important activities associated with the ISB hot spot remedial component, with respect to quality assurance, are the data collection and analysis activities for compliance and performance monitoring and facility operations with respect to amendment injection rate, concentration, and quantity. The quality assurance for these activities is described in detail in the ISB GWMP (INEEL 2002d) for compliance and performance monitoring and in the ISB O&M Plan (DOE-ID 2002b) for facility operational activities.

13. SAFETY AND HEALTH PROGRAM

The TAN OU 1-07B HASP (INEEL 2002e) establishes the procedures and requirements that will be used for all activities associated with OU 1-07B. The major field activities for ISB are facility construction, system operations, and maintenance and groundwater sampling. The HASP includes a hazard assessment for all anticipated activities and specifies procedures and equipment to be used for worker safety.

The safety and health requirements for ISB remedial action activities include the areas of industrial safety, industrial hygiene, fire protection, radiation safety, and emergency preparedness. Safety and health requirements, in accordance with Occupational Safety and Health Act (OSHA) Standard 29 CFR 1910.120 and 1926.65, "Hazardous Waste Operations and Emergency Response," are designed and established to provide a safe and healthy work environment. Safety and health requirements are being implemented at the INEEL through the DOE Integrated Safety Management System (ISMS) and the Voluntary Protection Program (VPP). The ISMS and VPP provide for the integration of hazard identification and mitigation into the work control process for construction, operations, and maintenance activities.

14. SCHEDULE AND BUDGET

This section addresses cost, schedule, and deliverables for ISB hot spot remediation activities. Also included is a cost comparison of the current project baseline and the cost estimate in the OU 1-07B ROD Amendment (DOE-ID 2001a). The current project baseline includes a refined cost estimate for ISB construction based on the "In Situ Bioremediation Remedial Design, Test Area North, Operable Unit 1-07B (Draft)" (DOE-ID 2002a).

14.1 Record of Decision Cost versus Current Baseline

Out-year funding availability for RD/RA projects is subject to congressional approval of DOE budgets. The DOE has identified adequate funding in existing budget plans for this project. Table 14-1 contains the project cost estimate from the OU 1-07B ROD Amendment (DOE-ID 2001a). This estimate and the assumptions contained in it may be used for comparison throughout the project. Depending on the outcome of the specified ROD and RD/RA SOW (DOE-ID 2001b) decision points, the actual remediation costs are expected to be within -30 to +50% of the ROD cost estimate.

14.2 Cost Estimate

The Federal Acquisition Regulations, Subpart 36.203(c) states that a detailed cost estimate cannot be disclosed to the public until the contract is awarded. This RAWP is a public document and as such, cannot contain detailed cost information related to ISB construction, ISB activities, or tasks that might be competitively bid. Table 14-2 provides a divisional breakdown of the estimated ISB construction costs. This estimate is based upon the ISB 90% design being provided with this RAWP. This estimate covers the cost of constructing the facility and ancillary features.

14.3 Schedule

The documents submitted to the EPA and IDEQ as deliverables are presented in Table 14-3, with the corresponding submittal dates, in accordance with Section XII of the FFA/CO (DOE-ID 1991). Milestone deliverable dates presented in Table 14-2 were established in the RD/RA SOW (DOE-ID 2001b), and where applicable, as modified by subsequent agency agreement.

Documents will have expedited and nonexpedited review and revision schedules. The review periods vary depending on the document. Draft primary documents (nonexpedited) have the standard 45-day review period. Secondary documents will have their standard 30-day review period. The DOE review will be concurrent with the EPA and IDHW review.

Figure 14-1 is the ISB RD/RA schedule containing the activities and interfaces necessary to accomplish the task detailed in this RAWP. The schedule ends with the completion of ISB optimization operations; long-term operation schedule activities will be detailed in a future revision to this RAWP following issue of the ISB remedial action report.

Table 14-1. Operable Unit 1-07B cost summary.

Description	Baseline Cost Estimate[a, b, c] FY-99 ($)	ROD Cost Estimate[a, b, c] FY-99 ($)
ISB Design	155,900	9,097
ISB Construction	819,000[d]	77,871
ISB Operations and Maintenance (FY-04 to FY-18)	3,002,076[e]	2,868,474
ISB Decontamination and Dismantlement	66,872[f]	29,692
Common Elements (Sunk Costs, NPTF Operations, MNA Operations)	33,931,322	33,931,322
TOTAL	37,975,170[g]	35,414,898

a. Dollars are net present value with a discount rate of 7%.

b. The baseline cost estimate includes actual cost through FY 01 and baseline-estimated cost for FY 02 through FY 18 (except as noted).

c. Costs were converted to FY-99 dollars based on a 7% discount rate.

d. Includes $458k for three new ISB wells. Note – the ROD cost estimate did not include well drilling costs.

e. $450,000 + 147,000 annually-first 5 years; $150,000 + 147,000-last 10 years.

f. Assumes ISB D&D would be completed in FY-2018. D&D in the ROD cost estimate was scheduled for FY-2031.

g. The ROD Amendment cost estimate was $35,414,898.

Table 14-2. ISB 90% construction cost estimate.

Operation	Cost ($)
Site Work	10,000
Concrete	9,000
Building/Enclosure	212,000
Well head Enclosures	15,000
Process System	100,000
Exterior Piping	49,000
Subtotal Direct Construction Cost[a]	395,000
Contingency (20%)	79,000
Reinjection Well and Monitoring Well	600,000
TOTAL	$1,074,000

a. Direct Construction costs do not include O&M contractor adders.

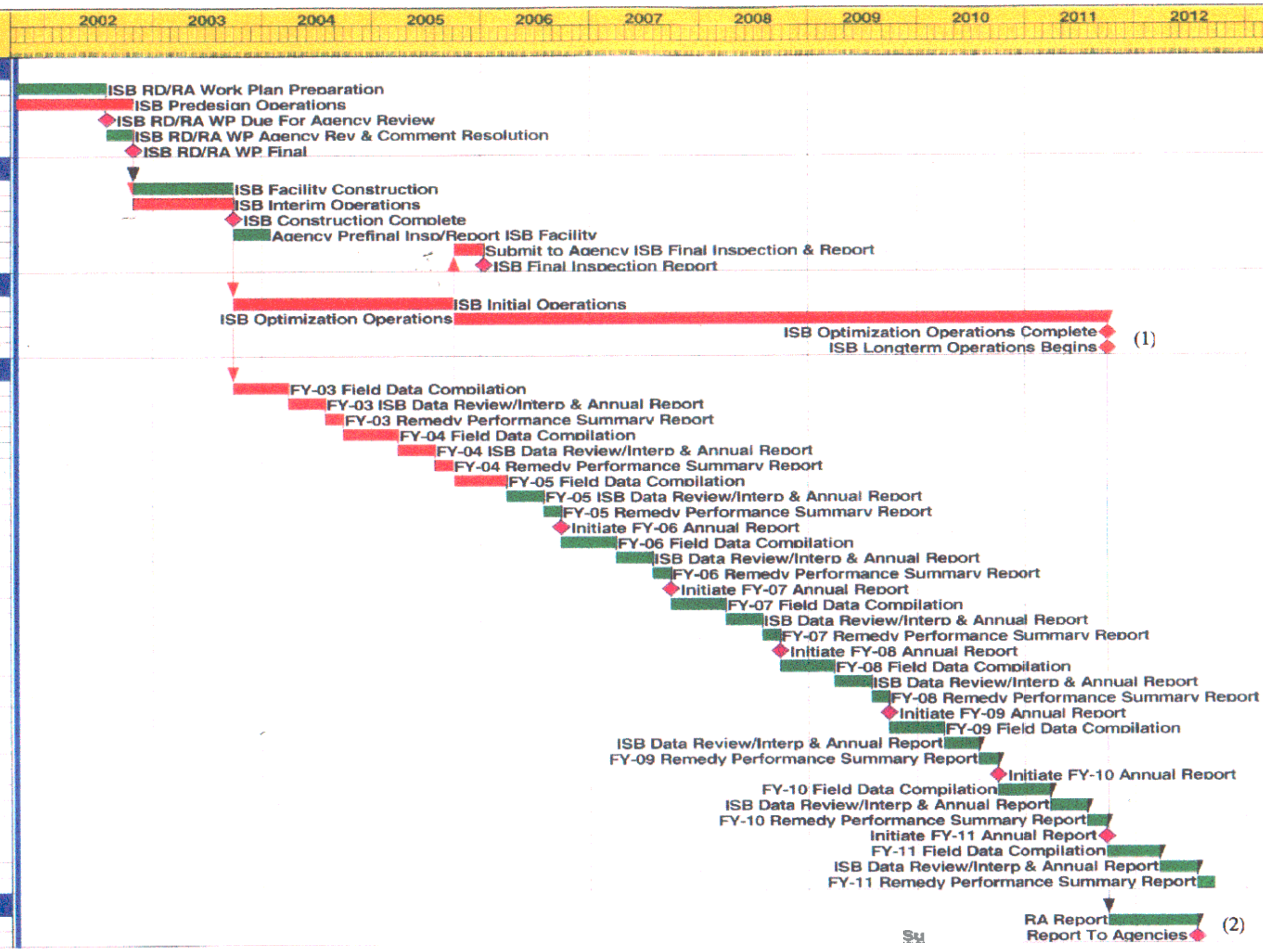
Table 14-3. Agency deliverable documents.

Deliverable	Planned Submittal Date	Enforceable Submittal Date	Review Duration (days)	Document Type
Hot Spot Remediation				
ISB Technical and Functional Requirements	March 2002	N/A	30	Secondary
ISB RAWP	July 2002	September 2002	45	Primary
ISB Pre-final Inspection Report	January 2004	March 2004	45	Primary
ISB Remedial Action Report[1]	TBD	TBD	45	Primary
ISB Performance Report	May 2002	N/A	INFO	External Release
O&M Plan, Revision[2]	TBD	TBD	45	Primary
ISB Annual Performance Report	July/yearly	N/A	INFO	External Release
O&M Report[3]	TBD	TBD	45	Primary
Remedy Performance Evaluation				
Remedy Performance Summary Report[4]	Annual/ Periodic	N/A	INFO	External Release

INFO = for information
N/A = not applicable
TBD = to be determined

1. Document deliverable date (to be determined) in the ISB Pre-final Inspection Report.
2. Deliverable date (to be determined) set in the ISB Remedial Action Report.
3. Deliverable date set in the ISB O&M Plan (DOE-ID 2002b).
4. Annual report first 5 years, periodic thereafter.

Activity Description	Early Start	Early Finish
ISB RD/RA Work Plan		
ISB RD/RA Work Plan	01OCT01	31JUL02
ISB Predesign Operations	01OCT01	29OCT02
ISB RD/RA WP Due For Agency		31JUL02
ISB RD/RA WP Agency Rev &	01AUG02	29OCT02
ISB RD/RA WP Final		29OCT02
ISB Construction		
ISB Facility Construction	30OCT02	30SEP03
ISB Interim Operations	30OCT02	30SEP03
ISB Construction Complete		30SEP03
Agency Prefinal Insp/Report ISB	01OCT03	30JAN04
Submit to Agency ISB Final	03OCT05	13JAN06
ISB Final Inspection Report		13JAN06
ISB Initial Operations		
ISB Initial Operations	01OCT03	30SEP05
ISB Optimization Operations	03OCT05	30SEP11
ISB Optimization Operations		30SEP11
ISB Longterm Operations Begins	03OCT11	
Performance Reporting		
FY-03 Field Data Compilation	01OCT03	30MAR04
FY-03 ISB Data Review/Interp &	31MAR04	30JUL04
FY-03 Remedy Performance	02AUG04	30SEP04
FY-04 Field Data Compilation	01OCT04	31MAR05
FY-04 ISB Data Review/Interp &	01APR05	01AUG05
FY-04 Remedy Performance	02AUG05	30SEP05
FY-05 Field Data Compilation	03OCT05	30MAR06
FY-05 ISB Data Review/Interp &	31MAR06	31JUL06
FY-05 Remedy Performance	01AUG06	29SEP06
Initiate FY-06 Annual Report	02OCT06	
FY-06 Field Data Compilation	02OCT06	29MAR07
ISB Data Review/Interp & Annual	30MAR07	30JUL07
FY-06 Remedy Performance	31JUL07	28SEP07
Initiate FY-07 Annual Report	01OCT07	
FY-07 Field Data Compilation	01OCT07	27MAR08
ISB Data Review/Interp & Annual	28MAR08	28JUL08
FY-07 Remedy Performance	29JUL08	26SEP08
Initiate FY-08 Annual Report	29SEP08	
FY-08 Field Data Compilation	29SEP08	26MAR09
ISB Data Review/Interp & Annual	27MAR09	27JUL09
FY-08 Remedy Performance	28JUL09	25SEP09
Initiate FY-09 Annual Report	28SEP09	
FY-09 Field Data Compilation	28SEP09	25MAR10
ISB Data Review/Interp & Annual	26MAR10	26JUL10
FY-09 Remedy Performance	27JUL10	24SEP10
Initiate FY-10 Annual Report	27SEP10	
FY-10 Field Data Compilation	27SEP10	24MAR11
ISB Data Review/Interp & Annual	25MAR11	25JUL11
FY-10 Remedy Performance	26JUL11	23SEP11
Initiate FY-11 Annual Report	26SEP11	
FY-11 Field Data Compilation	26SEP11	22MAR12
ISB Data Review/Interp & Annual	23MAR12	23JUL12
FY-11 Remedy Performance	24JUL12	21SEP12
ISB RA Report		
Prepare ISB RA Report	03OCT11	20JUL12
Submit ISB RA Report To		20JUL12



Start Date	01OCT01	Early Bar	ISB1
Finish Date	12MAR18	Progress Bar	BBWI
Data Date	01OCT01	Critical Activity	ISB RD/RA
Run Date	13JUN02 10:25		Classic Schedule Layout

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Sheet 1 of 1

Date	Revision	Checked	Approved

Notes:

(1) Duration of long-term operations is not shown on the schedule; a revised schedule will be prepared as part of the Remedial Action Report indicating the proposed completion date of the remediation.

(2) The actual submittal date for the Remedial Action Report shall be determined according to the ISB Pre-final Inspection Report.

Figure 14-1. ISB RD/RA schedule.

15. REFERENCES

29 CFR 1910.120, *Code of Federal Regulations*, Title 29, "Labor," Part 1910, "Occupational Safety and Health Standards," Section 1910.120, "Hazardous Waste Operations and Emergency Response," Office of the Federal Register.

29 CFR 1926, *Code of Federal Regulations*, Title 29, Part 1926, "Occupational Safety and Health Standards for the Construction Industry," Office of the Federal Register.

36 CFR 800, *Code of Federal Regulations*, Title 36, "Parks, Forests, and Public Property," Part 800, "Protection of Historic Properties," Office of the Federal Register.

40 CFR 61.92, *Code of Federal Regulations*, Title 40, "Protection of Environment," Part 61, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," Section 61.92, "Standard," Office of the Federal Register.

40 CFR 61.93, *Code of Federal Regulations*, Title 40, "Protection of Environment," Part 61, "National Emissions Standards for Hazardous Air Pollutants," Section 61.93, "Emission Monitoring and Test Procedures," Office of the Federal Register.

40 CFR 261.3, *Code of Federal Regulations*, Title 40, "Protection of Environment," Section 261.3, "Identification and Listing of Hazardous Waste," Office of the Federal Register.

40 CFR 262.11, *Code of Federal Regulations*, Title 40, "Protection of Environment," Part 262, "Standards Applicable to Generators of Hazardous Waste," Section 262.11, "Hazardous Waste Determination," Office of the Federal Register.

40 CFR 264, 2000, *Code of Federal Regulations*, Title 40, "Protection of Environment," Part 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," U.S. Government Printing Office, July.

40 CFR 300, 2000, *Code of Federal Regulations*, Title 40, "Protection of Environment," Part 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Office of the Federal Register.

40 CFR 761, *Code of Federal Regulations*, Title 40, "Protection of Environment," Part 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," Office of the Federal Register.

42 USC § 9601 et seq., December 11, 1980, *United States Code*, "Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA/Superfund)."

U.S. Department of Energy Order 420.1, 2000, "Facility Safety," U.S. Department of Energy, November 22, 2000.

U.S. Department of Energy Order 435.1, "Radioactive Waste Management," July 9, 1999, U.S. Department of Energy.

U.S. Department of Energy Order 5400.5, "Radiaction Protection of the Public and the Environment," January 7, 1993, U.S. Department of Energy.

Ackerman, D. J., 1991, *Transmissivity of the Snake River Plain Aquifer of the Idaho National Engineering and Environmental Laboratory*, U. S. Geological Survey-Water Resources Investigations Report, 91-4058.

Companywide Plan PLN-125, October 21, 1998, *Quality Program Plan for Environmental Restoration Program*, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho.

DOE-ID, June 2002a, "ISB Remedial Design, Test Area North, Operable Unit 1-07B (Draft)," DOE/ID-11013, Revision B, U. S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho.

DOE-ID, June 2002b, *ISB Operations and Maintenance Plan for Test Area North, Operable Unit 1-07B*, DOE/ID-11012, Revision 0, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho.

DOE-ID, September 2001a, *Record of Decision Amendment for the Technical Support Facility Injection Well (TSF-05) and Surrounding Groundwater Contamination (TSF-23) and Miscellaneous No Action Sites Final Remedial Action*, DOE/ID-10139, Revision 0, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho.

DOE-ID, November 2001b, *Remedial Design/Remedial Action Scope of Work Test Area North Final Groundwater Remediation Operable Unit 1-07B*, DOE/ID-10905, Revision 1, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho.

DOE-ID, March 2000a, *Field Demonstration Report, Test Area North Final Groundwater Remediation, Operable Unit 1-07B,* DOE/ID-10718, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho.

DOE-ID, September 2000b, *Quality Assurance Project Plan for Waste Area Groups 1, 2, 3, 4, 5, 6, 7, 10, and Inactive Sites*, DOE/ID-10587, Revision 6, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho.

DOE-ID, October 1999, *Final Record of Decision for Test Area North, Operable Unit 1-10,* DOE/ID-10682, U. S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho.

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Appendix A

In Situ Bioremediation Compliance with Applicable or Relevant and Appropriate Requirements

Table A-1. Compliance with regulatory requirements.

Category	Type	Regulatory Requirements	Implementation Strategy
Hazardous Waste Determination	Action	A person who generates a solid waste must determine if the waste is a hazardous waste by using the following method: 1) Determine if the waste is excluded under 40 CFR 261.4 2) Determine if the waste is listed as a hazardous waste in 40 CFR 261, Subpart D 3) For the purposes of compliance with 40 CFR part 268, or if the waste is not listed in subpart D of 40 CFR part 261, the generator must then determine whether the waste is identified in subpart C (characteristic) of 40 CFR part 261. IDAPA 58.01.05.006 {40 CFR 262.11}	Any waste streams generated during the remediation process for storage and/or disposal will have a hazardous waste determination performed. If needed, sampling will be conducted in accordance with a task specific sampling and analysis plan. All generated waste will be packaged, handled, and stored in accordance with the Phase C Waste Management Plan. Waste minimization activities will be implemented in accordance with the INEEL Reusable Property, Recycle Materials and Waste Acceptance Criteria. Trained personnel will inspect and ensure the CERCLA Waste Storage Units are in compliance with all applicable regulations.
General Waste Analysis	Action	General facility standards require that operators of a facility must obtain chemical and physical analyses of a representative sample of each hazardous waste to be treated, stored, or disposed of at the facility prior to treatment, storage, or disposal. The analysis may include existing published or documented data on the hazardous waste or on hazardous waste generated from a similar process. At a minimum, the analysis must contain all the information which must be known to treat, store, or dispose of the waste in accordance with this part and part 268 of this chapter. IDAPA 58.01.05.008 {40 CFR 264.13}	Waste stream management requirements are based on a waste evaluation supported by a project sampling and analysis plan and/or process knowledge. This information will provide the basis for determining; container requirements, storage requirements, labeling requirements, and treatment and disposal requirements. All waste (both radionuclide and VOC) generated during remediation operations will be managed through facility procedures in accordance with the Phase C Waste Management Plan.
General Facility Standards (Preparedness and Prevention)	Action	Treatment, Storage, and Disposal (TSD) operators must design, construct, maintain and operate facilities to minimize the possibility of fire, explosion or any unplanned sudden or non-sudden release of hazardous waste to air, soil, or surface water which might threaten human health or the environment. IDAPA 58.01.05.008 {40 CFR 264.31 through .35 and .37}	New and existing facilities will continue to be designed, inspected and operated in compliance with site procedures and the requirements of this section. New treatment systems and any modifications to existing facilities as well as current operations will consider the design and operational requirements of these sections when developing the design requirements.
Closure Performance Standards	Action	The owner or operator must close the facility in a manner that:	Once remediation activities have achieved compliance with remediation goals, closeout procedures will be

Category	Type	Regulatory Requirements	Implementation Strategy
		2) Minimizes the need for further maintenance, 3) Controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface water or to the atmosphere, and 4) Complies with the closure requirements of this subpart. IDAPA 58.01.05.008 {40 CFR 264.111} During the partial and final closure periods, all contaminated equipment, structures and soils must be properly disposed of or decontaminated unless otherwise specified in Sections 264.197, 264.228, 264.258, 264.280 or Section 264.310. By removing any hazardous wastes or hazardous constituents during partial and final closure, the owner or operator may become a generator of hazardous waste and must handle that waste in accordance with all applicable requirements of part 262 of this chapter. IDAPA 58.01.05.008 {40 CFR 264.114}	implemented. An evaluation of the equipment and storage areas will determine closure requirements and management of the materials, pump and treat equipment, and associated ancillary piping. Emphasis will be placed on minimal site O&M at completion of closure. All equipment, materials, and associated debris generated during project closeout will be adequately characterized to determine waste management requirements.
Container Management	Action	1) Remediation wastes will be kept in container meeting the requirements of 40 CFR 264.171; 2) Wastes will be stored with compatible containers; 3) Containers will be properly managed; and 4) The storage facility will be subject to inspections under 40 CFR 264.174. 5) The storage area containment system will be in accordance with 40 CFR 264.175. IDAPA 58.01.005.008 {40 CFR 264 Subpart I}	Characterization results via process knowledge or analytical results will dictate the packaging requirements, determine storage requirements, and compatibility with other wastes. Waste containers will be properly lableled and managed in accordance with existing operating procedures. All containerized waste will be subject to RCRA storage facility inspection requirements. If required, the storage containers will be stored within the CERCLA Waste Storage Area. Containers used to transport water extracted during groundwater sampling will not be double walled containers. If water is stored in these containers (>3 days) they will be placed in a container storage area with secondary containment. Any new treatment systems and any future facility modifications will be designed to provide adequate containment.

Category	Type	Regulatory Requirements	Implementation Strategy
			These requirements will be covered and implemented through the Phase C Waste Management Plan and respective Phase C Remedial Designs.
Land Disposal Restriction	Action	IDAPA Regulation 58.01.05.011 identifies that all of 40 CFR Part 268 and all subparts are herein incorporated by reference as provided in 40 CFR, revised as of July 1, 1994, except for 40 CFR Parts 268.5, 268.6, 268.42(b) and 268.44. Except as specifically provided otherwise in this part or part 261 of this chapter, the requirements of this part apply to persons who generate or transport hazardous waste and owners and operators of hazardous waste treatment, storage, and disposal facilities. Restricted wastes may continue to be land disposed as follows: 1) Where persons have been grated an extension to the effective date of a prohibition under subpart C of this part or pursuant to Section 268.5, with respect to those wastes covered by the extension; 2) Where persons have been granted an exemption from a prohibition pursuant to a petition under Section 268.6, with respect to those wastes and units covered by the petition; 3) Wastes that are hazardous only because they exhibit a hazardous characteristic, and which are otherwise prohibited from land disposal under this part, are not prohibited from land disposal if the wastes: a) Are disposed into a nonhazardous or hazardous injection well, as defined in 40 CFR 144.6(a); and b) Do not exhibit any prohibited characteristic of hazardous waste at the point of injection; and c) If at the point of generation the injected wastes include D001 High TOC subcategory wastes or D012-D017 pesticide wastes that are prohibited under section 148.179(c) of this chapter, those wastes have been treated to meet the treatment standards of Section 268.40 before injection. IDAPA 58.01.05.011	Wastes generated as a result of remediation efforts will be characterized for determining management requirements. Additionally, each waste stream will be evaluated to determine the applicability of LDRs. Waste streams subject to LDRs will be segregated and consolidated with compatible waste streams, as appropriate, when similar treatment technologies can be utilized. Waste streams generated from implementation of treatment technologies will be captured and appropriately managed based on classification.

Category	Type	Regulatory Requirements	Implementation Strategy
Water Quality	Action	Contaminated groundwater may not be injected back into the aquifer in which it came unless the groundwater is treated to substantially reduce hazard constituents prior to such reinjection. Section 3020 of RCRA.	Any extracted groundwater obtained during performance of OU 1-07B remedial activities will be processed through the NPTF prior to reinjection. Processing through the NPTF will substantially reduce the hazardous constituents.
Water Quality (Underground Injection Control)	Action	No chemical contaminants at concentrations above MCLs, or above the contaminant concentration of the receiving water can be injected in to the aquifer. No radionuclides above MCLs, or hazardous waste, can be injected into the aquifer. IDAPA 37.03.03	The design of the NPTF has incorporated the substantive requirements specified within this IDAPA regulation.
Water Quality (Monitoring)	Action	Monitoring, record keeping and reporting may be required if the well could adversely affect a drinking water source or if injecting a contaminant that could have an unacceptable effect upon the quality of the groundwaters of the state. The state may require (where appropriate), but is not limited to, the following: 1) Any injection authorized by the state shall be subject to monitoring and record keeping requirements as conditions of the permit; 2) The frequency of required monitoring shall be specified in the permit; 3) All monitoring tests and analysis required by permit conditions shall be performed in a state certified laboratory or other laboratory approved by the state; 4) Any field instrumentation used to gather data, when specified as a condition of the permit, shall be tested and maintained in such a manner as to ensure the accuracy of the data; and 5) All samples and measurements taken for the purpose of monitoring shall be representative of the monitoring activity and fluids injected. IDAPA 37.03.03.055.01	Any systems or components that inject materials into the aquifer during the remedial activities will meet these requirements as established in the individual work plans. Periodic monitoring will be performed to show compliance with this regulation.

APPENDIX B

DATA QUALITY OBJECTIVE DEVELOPMENT

APPENDIX B

DATA QUALITY OBJECTIVE DEVELOPMENT

1 DATA QUALITY OBJECTIVES

The DQO process is a series of planning steps designed to ensure that data of known and appropriate quality are obtained to support remedial response decisions (EPA 1993). The process uses qualitative and quantitative statements intended to clarify study objectives; define appropriate data types; determine appropriate conditions from which to collect the data; and specify acceptable levels of decision errors. The outputs of each step are then used as inputs in designing the sampling plan.

EPA DQO guidance (1993) generally recommends a seven-step process be used to implement the process to design both qualitative and quantitative (statistically-based) sampling and analysis plans for all CERCLA responses. This GWMP will utilize both qualitative and quantitative analysis of groundwater monitoring results, and of numerical modeling results, to determine progress of the ISB component of the overall OU 1-07B remedy. Not all steps apply to all data collection activities. The steps of the DQO process (EPA 1993) are listed below:

1. **State the problem**, including identifying the data users, the planning team, the primary decision maker, resources and deadlines

2. **Identify the decision to be made,** including the principal study question(s), alternative actions that could result from resolution of the principal study questions, and formulate and prioritize decision statements

3. **Identify inputs to the decision**, including required data types and sources, action levels, and analytical methods

4. **Define study boundaries,** including spatial and temporal aspects

5. **Develop a decision rule,** including (where appropriate) specifying the statistical parameter that characterizes the population, and (where appropriate) action levels for the statistical tests

6. **Specify limits on decision errors**

7. **Design the data collection program**, which will be implemented through this GWMP.

The first six steps are discussed in Sections 1.1 through 1.6 of this appendix, and the seventh step is addressed in Section 3 of this plan.

1.1 State the Problem

This level of the analysis summarizes the problem requiring new data, and identifies resources available to resolve the problem. The problems to be addressed in this GWMP are the OU 1-07B ISB compliance and performance objectives defined in Section 2.2 of the RAWP and listed below:

Compliance objectives:

- Reduce downgradient flux from the hot spot such that VOC concentrations are less than MCLs
- Reduce crossgradient flux from the hot spot such that VOC concentrations are less than MCLs
- Maintain the reduction of downgradient and crossgradient flux from the hot spot such that concentrations of VOCs are below MCLs.

Performance Objectives:

- Achieve electron donor distribution throughout the hot spot
- Achieve source degradation.

Remedy Component Performance Reports will be prepared annually between 2002 and 2007. These reports will present both performance and compliance monitoring data. Additionally, a numerical simulation, using MT3D for the ISB remedial action component, will be performed annually to determine whether or not the remedial action is progressing as predicted.

Regarding the performance and compliance monitoring strategies, the RD/RA SOW states: "Perhaps the most important aspect of this activity is the development of the evaluation process and decision logic to be used in determining the performance of each remedial component. If the evaluation process shows that the RAO will not be met, then the project and the Agencies will reconsider the implementation of the remedial component and determine, in accordance with the decision logic, whether a different operational strategy would make the remedial component successful at achieving the RAOs." The evaluation process considers qualitative and quantitative assessment of the data, as well as results of numerical modeling.

1.2 Identify the Decision

This step identifies the decisions that must be made, based on results of groundwater monitoring, and who will use the data. The immediate data users will be INEEL scientists and engineers analyzing trends to assess performance of ISB and electron donor distribution. Ultimate data users include INEEL and regulatory agency personnel who must periodically evaluate progress of the remedy relative to the RAOs and performance criteria cited above.

Based on the information provided in Section 2 of this RAWP and the remedy implementation sequence shown in Figure 1-1 of that section, decisions can be summarized as:

- Determine whether operational changes are required by routinely monitoring performance of the ISB system with respect to indicator parameters including VOCs, tritium, ethene/ethane/methane, redox parameters, electron donor, bioactivity, and nutrients.
- Determine whether or not downgradient flux of contaminants from the hotspot has been cut off, as evidenced by VOC concentrations below MCLs at TAN-28 and -30A.
- Determine whether or not crossgradient flux of contaminants from the hotspot has been cut off, as evidenced by VOC concentrations below MCLs at PMW-1 and PMW-2.
- Determine whether long-term operations are complete (the compliance criteria for long-term operations will be specified in the ISB Remedial Action Report).

1.3 Identify Inputs to the Decisions

This step identifies information required to make the decision, including specific data types, quality and quantity needed to support decisions. This stage of analysis must ensure that sufficient data of the required types, and of a quality appropriate for the data uses, are obtained. Results of this stage are typically used to define quality levels to be applied to the entire data collection effort, from sampling through analysis and data validation. Specifying unnecessarily stringent data quality costs the project time and money; while specifying insufficiently stringent data quality may result in failure to meet project objectives.

The EPA and QAPjP define data quality levels as "screening" or "definitive." Screening data are generated using rapid, less precise analytical methods with less rigorous sample preparation. Screening data both identify and quantify analytes, although quantification may be relatively imprecise. Screening data were used during the OU 1-07B ISB field evaluation and pre-design phases to monitor ISB performance, as discussed in the FY 2001 ISB Annual Report (INEEL 2002a). Screening data are adequate for performance monitoring, based on the results of that report. The EPA definition states that at least 10% of the screening data are confirmed using definitive analytical methods and QA/QC procedures and criteria. Screening data without associated confirmation data are not considered to be data of known quality.

Definitive data are generated using rigorous analytical methods such as approved EPA, American Society of Testing and Materials (ASTM), or other well established and documented test methods. Definitive data both identify and quantify analytes with relatively high precision and accuracy, and are typically used for compliance monitoring. Definitive data have been used during the OU 1-07B field evaluation and pre-design phases for compliance monitoring, and to confirm screening data. Definitive analytical methods produce tangible hardcopy, or electronic format, raw data (e.g. chromatograms, spectra, and digital readout values). Data not obtained and/or reported in these formats are documented in logbooks.

Inputs to each of the four decisions stated previously, including data required, data uses, and minimum data quality levels, are summarized in Table B-1. Requirements for decision input data, including action levels, analytical methods, method detection limits and data quality levels, are summarized in Table B-2.

1.4 Define Study Boundaries

The ISB component of the remedial action will focus on the OU 1-07B hotspot area (as defined in the ROD Amendment) and background wells located and screened in uncontaminated portions of the aquifer. The remedial action duration is estimated at 30 years, beginning in 2003, but will continue until the RAO is met.

Table B-1. Decision inputs.

Decision	Data required	Data use	Minimum data quality level required
1. Determine whether operational changes are required by routinely monitoring performance of the ISB system	VOCs Tritium Ethene/ethane/methane Redox indicators Bioactivity indicators Electron donor Nutrients	Performance monitoring-Trends in performance indicators (discussed in ISB O&M Plan) will be assessed. No quantitative action levels specified.	Screening
2. Determine whether axial flux of contaminants from the hotspot has been cut off, as evidenced by chloroethene concentrations below MCLs at TAN-28 and -30A.	VOCs	Compliance monitoring-VOC concentrations at specified locations will be compared to MCLs.	Definitive
3. Determine whether transverse flux of contaminants from the hotspot has been cut off, as evidenced by chloroethene concentrations below MCLs at PMW-1 and PMW-2.	VOCs	Compliance monitoring-VOC concentrations at specified locations will be compared to MCLs.	Definitive
4. Determine whether long-term operations are complete (the compliance criteria for long-term operations will be specified in the ISB RA Report).	VOCs	Compliance monitoring-TBD	TBD

TBD = to be determined

Table B-2. Data requirements for decision inputs.

Analyte	Action level	Analytical method	MDL[a,b]	Analytical data quality level attainable
VOCs				
TCE	5 ug/L	EPA 524.2 wide-bore capillary column	0.19 ug/L	Definitive
		SW-846 8260B	5 ug/L	Definitive
		SPME-GC-ECD	10 ug/L	Screening[c]
PCE	5 ug/L	EPA 524.2 wide-bore capillary column	0.14 ug/L	Definitive
		SW-846 8260B	5 ug/L	Definitive
		SPME-GC-ECD	10 ug/L	Screening[c]
cis-DCE	70 ug/L	EPA 524.2 wide-bore capillary column	0.12 ug/L	Definitive
		SW-846 8260B	5 µg/L	Definitive
		SPME-GC-ECD	10 ug/L	Screening[c]
trans-DCE	100 ug/L	EPA 524.2 wide-bore capillary column	0.06 ug/L	Definitive
		SW-846 8260B	5 ug/L	Definitive
		SPME-GC-ECD	10 ug/L	Screening[c]
vinyl chloride	2 ug/L	EPA 524.2 wide-bore capillary column	0.17 ug/L	Definitive
		SW-846 8260B	5 ug/L	Definitive
		SPME-GC-ECD	10 ug/L	Screening[c]
Dissolved gases				
Ethene	N/A	GC-FID	10 ug/L	Screening
Ethane	N/A	GC-FID	10 ug/L	Screening
Methane	N/A	GC-FID	10 ug/L	Screening

Table B-2. (Cont'd)

Analyte	Action level	Analytical method	MDL[a,b]	Analytical data quality level attainable
Redox indicators				
Sulfate	N/A	Hach Method 8051	4.9 mg/L	Screening
Iron	N/A	Hach Method 8146	0.03 mg/L	Screening
COD	N/A	Hach Method 10067	14 mg/L	Screening
pH	N/A	Hydrolab		Screening
ORP	N/A	Hydrolab		Screening
Electron donor				
lactate	N/A	Ion chromatography	5 mg/L	Screening
acetate	N/A	GC/FID	5 mg/L	Screening
propionate	N/A	GC/FID	5 mg/L	Screening
butyrate	N/A	GC/FID	5 mg/L	Screening
Nutrients				
ammonia nitrogen	N/A	Hach Method 10023 (for low range) Hack Method 10031 (for high range)	0.02 mg/L	Screening
orthophosphate	N/A	Hach Method 8048	0.05 mg/L	Screening
Bioactivity indicators				
alkalinity	N/A	Hach Method 8203		Screening
specific conductivity	N/A	Hydrolab		Screening

a: Method Detection Limits (MDLs) for EPA method organics and radionuclides are from DOE/ID-10587, *QAPjP for WAGs 1, 2, 3, 4, 5, 6, 7, 10 and Inactive Sites*; for Hach methods are from the Hach Manual; for Hydrolab parameters are from the Hydrolab manual; for SPME organics, lactate/acetate/propionate/butyrateare from Cathy Rae, personal communication.

b: Per DOE/ID-10587, "Detection limits must not exceed one tenth the risk-based or decision-based concentrations for the contaminants of concern." This applies to definitive attainment or compliance monitoring only, for purposes of this GWMP.

c: the SPME-GC-ECD results do not meet the QAPjP definition of definitive data as "…generated using rigorous analytical methods, such as approved EPA or ASTM reference methods or well-established and documented test methods." and are therefore considered screening data.

SPME-GC-ECD = solid-phase microextraction-gas chromatography-electron capture detector, an analytical method used during the ISB field evaluation and pre-design phases for chloroethene determinations.
GC-ECD = gas chromatography-electron capture detector

1.5 Develop a Decision Rule

Decision rules should contain four main elements (EPA 1994) including:

- The *parameter of interest* (e.g., a descriptive measure that specifies the characteristic or attribute that the decision maker would like to know about a statistical population)
- The *scale of decision making* (i.e., the smallest, most appropriate subset of the data for which separate decisions will be made)
- The *action level* a measurement threshold value of the parameter of interest that provides the criterion for choosing among alternative actions (e.g., a regulatory standard or other risk-based level)
- The *alternative actions*, which are the actions that the decision maker would take depending on the true value of the parameter of interest.

Decisions 2 and 3 have quantitative action levels, therefore quantitative decision rules are defined for these. Decision 1 does not have quantitative action levels; performance trends will be tracked to support this decision. (These performance trends will be assessed and reported in ISB annual reports.) The OU 1-07B ISB Remedial Action Report will define Decision Rule 4, and methods for determining the end of the remedial action.

EPA (1992) offers guidance on assessing multiple wells individually vs. as a group. If assessed individually, then the site can be declared clean only if the groundwater in each well attains the cleanup standard. The greater the number of wells tested, the greater the likelihood of a false negative decision in at least one well, resulting in an overall non-attainment decision. However, assessing all wells individually can result in relatively greater protection of human health and the environment because all concentrations must attain the cleanup standard in spite of false negative decisions.

Alternatively, all wells may be tested as a group. Measurements from each well are combined into a summary statistic for each sampling event. The groundwater for the group of wells would be declared to attain the cleanup standard if the summary statistic was significantly less than the cleanup standard. The summary statistic could be the average (mean) for the group or the maximum concentration from the group of wells. Using the maximum for the group means that each well individually must attain the standard.

Based on cost-effective protection of human health and the environment, the decision rule will utilize the average concentration for each well group, i.e., TAN-28 and –30A; and PMW-1 and -2. Use of results less than detection limits in these calculations will be discussed and decided with the Agencies before determining compliance with a decision rule, or determining when the remedy is complete.

The EPA (1992) further suggests specific parameters to test when comparing the cleanup standard to the mean concentration of a chemical with chronic effects, with respect to the variability expressed as coefficient of variation (CV) and concentration range of the data. Suggested parameters and values are shown in Table B-3.

Less than 30% of ISB sampling locations might be expected to have VOC concentrations below detection limits during attainment monitoring, given that the required detection limits are an order of magnitude below MCLs. Coefficients of variation are expected to be intermediate. Therefore, the suggested cleanup standard attainment test parameter is the mean or upper percentile.

Table B-3. Recommended cleanup standard attainment test parameters relative to data properties.

Coefficient of Variation	**Proportion of the data with concentrations below the detection limit**	
Variability of data	**Low (<30%)**	**High (>30%)**
Large CV (>1.5)	Mean or upper percentile	Upper percentile
Intermediate CV	Mean or upper percentile	Upper percentile
Small CV (<0.5)	Mean or median	Median

Quantitative decision rules are therefore defined as follows:

- **Decision Rule 2:** If average VOC concentrations at ISB wells TAN-28 and -30A do not exceed risk-based levels for four consecutive quarterly monitoring rounds, then the remedial action will be determined to have cut off downgradient flux from the hotspot and the remedial action may be modified. If the decision rule is not supported by the data, then the remedial action will be continued.

- **Decision Rule 3**: If average VOC concentrations at ISB wells PMW-1 and PMW-2 do not exceed risk-based levels for four consecutive quarterly monitoring rounds, then the remedial action will be determined to have cut off crossgradient flux from the hotspot (i.e., met the ISB performance criterion) and the remedial action may be modified. If the decision rule is not supported by the data, then the remedial action will be continued.

1.6 Specify Limits on Decision Errors

The EPA (1992) provides guidance on statistical tests used to establish attainment. Limits on decision errors are stated as α, the acceptable probability of determining that the aquifer is clean when it is not (i.e., a false positive result). Regarding false positives, the guidance states that:

- Reducing the chance of a false positive decision helps to protect human health and the environment

- A low false positive rate does not come without cost; the additional cost of lowering false positive rates comes from taking additional samples and using more precise analysis methods.

Typically, the maximum acceptable probability of a false positive decision is set at 1 to 10%, with input from all planning team members. The preliminary allowable decision error probability is defined as 10%.

1.7 Design Data Collection Program

The final step in the DQO process is to design a program to cost-effectively collect data that will meet the DQOs. This program is described in Section 3 of the OU 1-07B ISB GWMP (INEEL 2002d).